THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XII.—No. 288.

PRIMARY BATTERIES.

THE probability that a highly efficient and original form of secondary battery would be of considerable commercial value has for the last year or two thrown the current of invention strongly in this direction, whilst primary batteries have been comparatively neglected. It is true that a certain amount of work in the direction of improving primary batteries has been done, but the results have commanded but little, if any, attention. As a source of power either for electric light or electromotive purposes, the primary battery cannot at present hope to play an important part, though we could not venture to assert that in the future it will not prove an economical source of electricity. Undoubtedly very great advances require to be made, but that they cannot be made it would be unsafe to predict.

For telegraphic purposes we think primary batteries will prove indispensable for a long time to come, and there is a considerable field for improvement in this direction. Telegraph batteries are still a long way from perfect; they are decidedly wasteful, and give far more trouble than they ought. For constancy the Daniell has never been equalled, it will stand the heaviest work without any tendency to exhaustion, and, in fact, the more heavily it is worked the more economical does it become. A Daniell battery when lightly worked consumes a very great portion of its active material in local action, and when not worked at all in a very short time it exhausts itself, and its cells become choked with a mass of decomposed chemicals. The Leclanché is a contrast to the Daniell as regards cleanliness, yet it is by no means perfect in this respect; the phenomenon known as "creeping" has never been wholly eliminated in the Leclanché, at least in those forms of the element which are not hermetically sealed up. This "creeping" is a most annoying source of deterioration in all batteries, and nothing seems capable of effectually eradicating it. But the Leclanché, in spite of its many excellent qualities, is useless for producing powerful and constant currents for a lengthened period.

For telegraph purposes the bichromate battery of Mr. J. Fuller is now being very extensively used, and in spite of the many assertions that it cannot be considered to be a new invention, it possesses sufficient points of novelty to come under the latter category. The bichromate battery as originally constructed did not answer for telegraphic purposes; the bichromate battery as arranged by Mr. Fuller proves to be highly efficient and useful; this fact, one would think, is sufficient to make it a novelty. The bichromate is, however, by no means free from local action, and the smaller the resistance of its porous cell the greater is the local action that takes place when the battery is not comparatively heavily worked. A battery is like a very leaky cistern, if you draw off the water quickly you will lose very little of it, but if you draw it off slowly a large amount will be lost by the leakage. The most powerful batteries are decidedly very leaky, but how to get rid of the leaks is a problem which no one has yet been able to solve satisfactorily. The liability of the zinc in a battery to dissolve unequally has recently been much reduced, if not entirely avoided, by a novel invention, patented by Messrs. Burr and Scott. These gentlemen very thinly *gild* the surface of the zinc element and then coat the gold with a film of mercury; this process almost entirely gets rid of the local action which usually disintegrates the zincs. It is difficult to understand the part which the gilding plays, but that it is effectual is, we believe, unquestionable. In telegraphy, as we have said, there is an undoubted field for workers in the direction of batteries; there is also a field in the domain of electric power; but the difficulties to be overcome in this direction are very much greater than in the case of telegraphy, as the economical view of the question has very great weight. Primary batteries, however, would, in many cases where temporary electric light installations at a short notice are required, prove very useful.

SECONDARY BATTERIES AND THE ELECTRICAL STORAGE OF POWER.

AT the Society of Arts, John Street, Adelphi, on Monday evening of last week, Professor Oliver J. Lodge, M.A., D.Sc., delivered the first of two lectures on the above subject. Dr. Mann presided, and introduced the lecturer.

Professor Lodge said the methods of storing energy were very numerous. They might store it mechanically or they might store it chemically. He had put down on the syllabus "electrical methods of storing energy," but, as a matter of fact, he thought they might resolve all apparently electrical methods into either mechanical or chemical; at any rate, into electro-mechanical or electro-chemical. After giving several illustrations of the storage of energy by both mechanical and chemical processes, the lecturer described the general principles of secondary batteries, and in regard to the plates said that what they wanted was a plate to hold the oxygen and become oxidised. Lead forms an insoluble oxide and was consequently suitable for the purpose. A few others were insoluble, but lead had the advantage. It was better than either silver or manganese for the reason that its oxide was less soluble. They had the plate gradually eaten into by the oxygen, hence the storage of a large quantity of energy. What became of the hydrogen? Did the lead plate absorb the hydrogen? He thought it did to some extent, and that the lead became hydrogenised. Dr. Frankland said it did not. Dr. Frankland was most likely right, but on the hypothesis that the lead absorbed no hydrogen, and that the lead was lead pure and simple, he could not understand how he obtained certain results by certain experiments. He must there say a word about the positive and negative plates. Some people called the one plate positive and the other negative, and others *vice versâ*. The matter was simple. If one decided to call that the positive plate by which the current entered and from which the discharged current left, they were not to call it sometimes the positive and sometimes the negative; the positive when charged and the negative when discharged, that led one into intolerable confusion. Supposing (experimenting with a small cell) he took away the negative or hydrogen plate and replaced it by a bit of clean lead, according to Dr. Frankland the negative plate did not differ from clean lead—it absorbed no hydrogen—it was nearly exhausted—it gave a current for only a second or two. To prove that it was not the positive plate which was exhausted he should remove the clean lead and put in an old piece of lead which had not replenished itself. It showed more strength, and so he thought the plate in that respect must differ from ordinary lead, and how it differed he could not understand, except in consequence of the hydrogen. When the cell itself ran down, which, he would ask, was the first

to fail? Did the negative plate fail first and become exhausted of its hydrogen, or did the positive plate become deoxidised, or did they both fail together? He tried that experiment by immersing the plates a little bit in the liquid and letting that little bit of each exhaust itself, and then introducing a little more of the plates and seeing which caused the current to renew itself. He stopped the charging current; he raised the plates, immersing only about a quarter of an inch of each, and then discharged them. He discharged them by putting on the galvanometer and the bell (attached to the cell with which he was experimenting), and they would hear that the bell and see that the galvanometer were weak. Now, that (pointing to the positive plate) was exhausted. If he let it stand it would recover itself in a little; if they let it stand a short time it would give a current for a short time; if they let it stand a longer time it would give a current for a longer time. Now, having exhausted it, let him dip the positive plate a little deeper in, bringing a new surface of positive plate to bear. That did not do much good. Let him bring a new surface of negative plate to bear (showing more energy). It was that which was exhausted. The tip of the negative plate was exhausted before the tip of the positive plate, and therefore he must have a fresh negative. The positive would go on much longer than the negative. He would charge up again. Now, that (pointing) was the form of the secondary battery until the time of Planté. The improvement of Planté consisted in not only giving an oxidisable plate but a reduceable plate, and he got his reduceable plate simply by reversing the cell. If they reversed the charging battery they would then make the peroxidised plate the negative. The other plate became the positive. So by perpetual reversals Planté managed to get the plates into a thoroughly porous or spongy condition for some depth. The modification which Faure introduced into the Planté cell was to get the reduceable plate without those great number of reversals. Planté coated the plate before proceeding to charge it with minium or red lead—an imperfect and non-conducting oxide—a porous substance through which the current would penetrate. The oxygen was liberated on the surface of the lead plate, which again became peroxidised, but the peroxidisation went into the lead plate, and spread out until all was peroxidised or coated, and when that happened gas began to give off. Until that happened nearly all the gas was absorbed. If they coated the negative plate with the same kind of stuff, they had a reduceable plate practically. The hydrogen liberated on the plate did not escape, consequently they had no escape of gas on either plate until the cell was full. If the quantities were properly adjusted the two plates would get full together; but the oxygen generally commenced to escape before the hydrogen. In the process, which was quicker than the Planté process, of forming a Faure cell no reversals of currents, as he had said, were used. The operation took a week, or perhaps not so long; the Planté operations took two or three months. In making the Faure cells it was not found easy to keep the coatings on the plates, and the plates had to be wrapped up in felt or cloth. The next improvement consisted in not using coatings at all so much as putting the substance which formed the coatings into interstices in the lead. This was a patent of Mr. Swan and Mr. Sellon. The plates now were all made with perforations, and the substance adhered to them very much better. The Electrical Power Storage Company had been good enough to lend him the specimens of cells, &c., before them. The plates were of two sizes. They were packed together in boxes. The only difference in the cells was in the number of plates. The amount of electricity that could be stored up in the small plates might be stated at 16 ampère-hours, and the current varied from two to three ampère-hours; consequently those boxes which had nine pairs of plates would take a current of about 20 or 30 ampères, and give out about the same. They would discharge at that rate between six and eight hours, giving out a quantity of about 160 ampères. There was great excitement about the Faure battery when it first came out, and public attention was directed to it to rather an exaggerated extent. Recently the interest in it abated, and very little was known as to what was being done. He had in his laboratory at Liverpool 25 of these cells. He found them most invaluable, and was surprised at the perfection produced in them during the last year. The difference between putting the coating on the plate and into the interstices struck him as a very small improvement, but if they put it to the test of practice it seemed to be an improvement. The chemical process which went on in discharging the plates was very much the reverse of that which went on in charging. If the cells were kept in full action, they were preserved in a remarkably perfect state of efficiency, but if they allowed them to stand idle and electrically empty the negative plates rapidly sulphated themselves up, and the composition lost its adherence and was apt to tumble out. Many of the defects to be found in cells was due to this illtreatment. If they kept the battery in action it behaved exceedingly well. The only way to get rid of the sulphate was to apply a small charging current for a long time—a week or a fortnight—and start afresh. The sulphate of lead on the positive plate did not matter so much. The electromotive force of a cell was about two volts. They must never keep the cells full or drain them. They thus got a good return for the energy they put in. The lecturer concluded by briefly referring to meters. Ayrton and Perry's meter, he said, was a remarkable instrument; it was a somewhat striking example of the improvements introduced into pure science by the acquirements of technical science.

THE ELECTRICAL TRANSMISSION OF POWER.

[Note* by M. G. CABANELLAS upon a Fundamental Theoretical Point in the Report presented by M. CORNU.]

I SHALL have the honour of producing eventually the complete discussion of the experiments officially controlled by the Académie at the Gare du Nord; they contain several conclusions of great interest. At present I shall only examine the theory which leads to the establishment of the new formula—

$$\frac{T_u}{T_m} = \frac{e}{E} H h,$$

according to which the dynamometrical yield would equal the product of three factors: 1st, the electrical yield $\frac{e}{E}$; 2nd and 3rd, the co-efficients, H and h, which should be the practical co-efficients of transformation of energy of the two machines.

The report determines the electromotive forces by the formulæ $e = u - r\,I$, $E = U + RI$, and the co-efficients by the formulæ—

$$h = \frac{T_u}{eI \times \frac{I}{75g}},$$

$$H = \frac{EI \times \frac{I}{75g}}{T_m};$$

substituting for e, E, h, H, these values, we have the equation—

$$\frac{T_u}{T_m} = \frac{T_u}{T_m}.$$

Thus any, even false, values of u, U, r, R, I, would furnish apparent verifications of the formula; this must be kept in view to avoid misinterpretation of the following passage in the report: "We see thus *why* the dynamometrical yield is always less than the electrical yield." From its origin, the formula with three factors is necessarily deprived of all significative or explanatory value.

The fundamental point of theory which it is important to point out is as follows: The report calculated the electromotive forces by the formulæ

$$e = u - rI = E = U + RI,$$

in which r, R, are the static resistances measured with the ring motionless, which is at least begging the question, since machines in motion were being examined; but, besides, our

* *Comptes Rendus.*

former attempts have shown that to render these formulæ applicable to machines in motion, we must give to r, R, their respective dynamic values, according to the regulation of speed. The values of e, E, being falsified by the successive repercussions, the report inevitably falsifies

$$\frac{e}{E},\ h,\ H.$$

In fact, if we call D, d, the deficits of power of the two Grammes machines (kilogrammetre-seconds) we have really

$$e = u - r\,I - g\frac{d}{I} \text{ and } E = U + R\,I + g\frac{D}{I}.$$

Making a final analysis, we find it is the electromotive force E, of the generator which fills up the two deficits of the two machines, and we have therefore—

$$E = e + I\,(R + \rho + r) + g\frac{D + d}{I},$$

and

$$T_m = T_u + \frac{1}{75g}\,(R + \rho + r)\,I^2 + \frac{1}{75}\,(D + d + \ell'),$$

ℓ' being the passive mechanical power (friction of the receiver). We remember that the deficit of power of machines with collectors, of which we were the first to give the Académie the indication and the accurate measurement, has been disputed for a long time, but is now officially recognised since the reports of M. Tresca. That this deficit exists is sufficient to establish the certainty of our previous conclusions. We need not here trouble ourselves to ascertain whether it is desirable to admit as an explanation of this fact an increase in the metallic electrical resistance of the wire of the ring, or a counter-electromotive or self-inductive force. It is sufficient that there is a resulting deficit for it to be expressed in other terms by a fixed number of volts, which has been actually deducted from E, since I has circulated just the same. (The direct experiment shows that if we make a Gramme ring revolve, with the circuit open, in a powerful magnetic field, no appreciable parasitic current producing disadvantageous consumption of energy is generated, which does not imply the absence of the deficit of power in the working of the ring when it does work, the deficit being able to be very considerable nevertheless, but which shows that all the electromotive forces due to the action of the field will be practically turned to account in the useful circuit of the machine.)

In the conditions of the note, applicable to the case,

$$\frac{1}{75\,g}\,E\,I$$

rigorously represents T_m, so that the passive mechanical frictions of the generator being counted, by the report, outside of what it calls T_m, we have invariably at all speeds,

$$E = \frac{75\,g\,T_m}{I};$$

the principle of the conservation of energy requires it absolutely; it is only beyond this first inflexible link of the transmission of an unalterable quantity of energy that it will be our right and duty to consider the deficit of power of the generator of electricity. H is therefore in no way a practical co-efficient of the transformation of energy of the generator, since in reality the value of it is always invariably equal to unity, for all speeds, with all machines of good or bad individual rendering, provided that there is no leakage, no parasitical currents out of the main circuit, and however great or however small the deficit of the machine may be as compared with its power. It results equally from this, that h is no longer a co-efficient of the transformation of the receiver, since with any machine whatever, electrically advantageous or not, the value of h will never differ from unity except by reason of the frictions of the bearings of the receiver and of its other passive resistances to rotation (passive in a purely mechanical sense).

In summing up, I seem justified in concluding that we must renounce the formula

$$\frac{T_u}{T_m} = \frac{e}{E}\,H\,h$$

the establishment of which rests upon the necessity of giving at once false values to the four quantities e, E, H, and h.

On the contrary, when we determine e and E by observations and by formulæ adapted to each experimental fact, according to the accurate methods which I gave formerly, we prove that

$$\frac{T_u}{T_m}$$

really equals

$$\frac{e}{E}$$

This formula has always been true and will always be true, independently of the form of the electrical apparatus, whatever it is. (I communicated to the Académie a numerical application of my method for the reconstitution of the electrical elements and of the rendering of transmission when I reduced to 21 or 15 per cent.—according to what was taken into account—the 68 per cent. which M. Deprez thought he had reached in the transport from Wiesbach to Munich).

Practically, this equality is true only when we disregard the mere mechanical resistances of the receiver (friction of the bearings, resistance of the air, &c.). That is to say that

$$\frac{e}{E}$$

gives even accurately the dynamometrical rendering.

$$\frac{T_u}{T_m}$$

if e is calculated by the formula

$$\frac{75\,g\,T_u}{I},$$

because this last formula gives what I call the net contra-electromotive force of the receiver, or in other terms, that proportion of the electromotive force capable of being converted into power which is actually available and collected at the brake.

Our conclusions are therefore utterly at variance with the Report (p. 106):—"Experiment shows that the electrical rendering is notably higher than the dynamometrical rendering; whence a grave objection to the validity of the electrical theory of the transport of force. . . ."

We are opinion, on the contrary, that experiment is, upon this point, in perfect accordance with the former admirable theoretical unity; only we must certainly give to the electromotive forces the values which they really have in each actual experiment.

ELECTRICITY AS A MOTIVE POWER.

By Prof. GEORGE FORBES.

(*Continued from page* 433.)

AT the site of the Severn Tunnel there is a width of river of two and a half miles, where the average rise of tide is 50 ft. If the average rate of flow across this section were one mile per hour, we could utilise 100,000 horse-power, and the market value of that power is something like £1,000,000 per annum, which is now allowed to be wasted. It is worthy of the most serious consideration whether it would not be worth while to erect the enormous engineering works which would be required to utilise this wasted energy, or rather a portion of it. Assuming the interest and depreciation on the turbines and dynamos to be at the rate of £2 per annum per horse-power (and it would be far less than this for a large installation, it is easy to see that a time will come when this source of wealth will not be allowed to be wasted.

I wish to draw special attention to this point, because I have frequently heard people say, with regard to the utilisation of the tides, "Oh! that is out of the question. Sir William Thomson has proved that the area required to produce 100 horse-power is so great that it would be more worth while to reclaim the land and cultivate it." Now Sir William never said such a thing. It is true that at the York meeting of the British Association, he showed what area would require to be enclosed in order to produce 100 H. P. on the supposition that there was a rise of tide of only 6 ft. 7 in. (2 metres). And he made use of the following expression:—"Thus we are led up to the interesting economical question, whether is forty acres . . . or 100 H. P. more valuable." But in the case I am considering the height of the tide is six times that contemplated by Sir William, and the question is rather "whether is forty acres or 600 H. P. more valuable." The estimate I made above as to the value of a horse-power, agrees with Sir William's; and the value of 600 H. P. is £6,000 per annum. I confidently state that the reclaimed land on the Severn would not be worth £150 per acre per annum. I have taken the site of the Severn Tunnel as an example, but there are many other places available, and I have little doubt that the industrial population at Bristol will soon realise the wealth of power at their doors.

Some people in this country are timid about the introduction of large turbines. This, I need hardly say, is a gross prejudice. At Connecticut, Massachusetts, 30,000 H. P. is derived from the river

by turbines. At Narva, near St. Petersburg, one firm uses 12,000 H. P., and the size of the turbines used, which were made at Augsberg, was limited only by the size of the tunnels on the railways by which they had to be conveyed. At Munich I saw 260 horse-power rendered available by means of turbines with a fall of less than two metres. In the remote valleys of Italy there are several installations of incandescent electric lighting by means of turbines driving the machines of Messrs. Crompton. In Scotland, too, we have powerful turbines. Mr. Pirie, the paper-maker, has introduced, near Aberdeen, turbines working up to nearly 1,000 horse-power. At Greenock large overshot wheels are employed. The Shaws Water Worsted Company are now replacing one of these, of 200 horse-power, by a turbine. In Lancashire water-power is also extensively used. At Valserine, on the Rhône, a canal has been cut through the rock, a third of a mile in length, thus giving a fall of about 12 metres and many hundred horse-power, using Jonval turbines. It is proposed to use the falls at Bellegarde, near Geneva, in the same way. The Manville Cotton Company, at Albion, R. I., use turbines, with a fall of 5·4 metres, which takes the place of a steam-engine of 800 horse-power, and economy is materially gained, although during the five months of the dry season they are obliged to use steam. At the Pittsburg Mill, Minneapolis, there is a Victor turbine, working up to 1,400 horse-power, and another is being added of the same dimensions. These are only a few examples to show how thoroughly practical, economical, and convenient the use of turbines has become. We can with them calculate on utilising 75 per cent. of the theoretical power of the head of water. They can be controlled with the utmost ease. Their cost is very small compared with water-wheels, and they can be geared directly on to the shafts of dynamos. As an example of their adaptability to the purposes of the electrician, I may mention the performance of a Fourneyron turbine established at St. Blaise in the Black Forest, which utilises a fall of 108 metres, turns at a speed of 2,300 revolutions a minute, and gives off 60 horse-power.

The engineering works which would be required on the Severn would be very simple, though on a large scale, and the action could be made quite continuous, independently of the state of the tide, and without any necessity of using accumulators.

Having now spoken of the applications of electricity to stationary engines, let us see what has been done, and what can be done, with respect to locomotives. There are two ways in which this application has been made. First, by storing the electricity in accumulators, and putting the accumulators in a tram-car, a boat, or a tricycle, and second, by deriving the current from a wire or other conductor placed along the line. The experiments made upon the first plan are very interesting, but their practical value is limited, owing to the weight and expense of the accumulators. I think that it would be far more economical to use compressed air-engines. Ever since 1875, when I examined the compressed air tram-car of Scott Moncrieff, which ran so successfully in Glasgow, I have felt sure that this must become eventually the motive-power for tram-cars, and I have not yet seen anything to lead me to alter my opinion.

What has been done in the second way of proceeding? We will see that considerable progress has been made. At the Berlin Exhibition in 1879, Messrs. Siemens and Halske drove a train of a few carriages round a circular tramway, the gauge being three-quarters of a metre. In April, 1881, the same firm constructed the Lichterfelde and Berlin electrical railway, which is two miles long. One of the carriages of this railway was shown at the Paris Exhibition of 1881. The current is passed through the rails, which are insulated. It is then taken up by the wheels, and so passed through the motor. The motor turns at a very rapid rate, but it is geared to the wheels of the carriage by belting of wire-rope, which reduces the speed of revolution. The carriage has the appearance of an ordinary tramway-car, and the machinery is invisible. It was expected that snow might prove troublesome in such a system where the current is passed through the rails, but the winter of 1881-82 was so mild as to give no trouble. I have not heard whether any difficulty presented itself during the past winter. At the Paris Electrical Exhibition a somewhat similar car was used, but Messrs. Siemens were not allowed to pass the current through the rails on account of the danger to horses, &c.; hence they were obliged to carry conductors, consisting of split tubes, on telegraph poles, and a small carriage fitting into the tubes made electrical contact with the motor on the car. Another electric railway has now been completed by the same firm between Charlottenburg and Spandauer Bock. In this case, also, a contact carriage is used, as at Paris. This line is three and a-half kilometres long; two and a-half kilometres are level, but this line is specially interesting from the fact that a whole kilometre is on the considerable incline of 1 in 28. Messrs. Siemens have also applied the same principle to haulage in mines. A small electrical locomotive is used in a mine near Dresden to drive eight corves loaded with coal. Finally we have the electrical tram-car running on the Portrush line, in the North of Ireland; but this has been so well described in this room, and so recently, that I need only mention it.

It has always seemed to me that the principal advantage which would be gained by using electricity as a motive power for railway trains, lies in the great facility with which motive power could be applied to every wheel of the whole train. Captain Douglas Galton, in the concluding paragraph of his report on experiments conducted by himself and Mr. Westinghouse, on continuous brakes, says:—The advantage which thus evidently ensues from utilising the adhesion of every wheel of a train, suggests the further consideration as to whether it would not be a more scientific arrangement as well as being more economical in regard to the permanent way of railways, to utilise the adhesion of every wheel of a train for causing the train to move forwards instead of depending for the moving force upon the adhesion of one heavy vehicle—viz., the locomotive."

Certainly, there can be no doubt that it would save the permanent way from tear and wear and the passengers from the shocks which are so unpleasant. But it is only by means of electricity that the proposition is practical. Moreover, the moveable parts of a locomotive are not perfectly balanced, and this limits the speed at which it can go. With an electrical motor the balance is perfect. By utilising a motor on every wheel you could go safely round curves at far greater speed. I feel sure that in this way it would be safe for trains to go at double the speed they do at present, and I hope to live to travel from London to Edinburgh in three and a-half hours, smoothly, and without jolting. Furthermore, a train, instead of taking several minutes to get up full speed, could do so in a few seconds. This follows from the same reasoning as is applied to continuous brakes. Lastly, if there were power enough, a train could go up a steep hill instead of being confined, as practically they are, to an inclination of 1 in 80. In a district with heavy goods traffic, this might be a great advantage.

These considerations appear to me to be so important, that I must pause awhile to make them clear.

First.—As to getting up speed quickly. With an ordinary train, weighing ten times as much as the engine, the theoretical minimum of the time required to get up a speed of thirty miles an hour is one minute, however powerful the engine may be. The reason is that the wheels would slip if the motion were accelerated more rapidly. But if power were applied to every wheel, it would have a speed of 30 miles an hour in six seconds, and with no more jerks than is now felt when a continuous brake is applied.

Second.—As to the going up hill. The same advantage here is gained as would be gained by continuous brakes. An ordinary train when the lines are in an average condition, slips down an incline 1 in 50, when the locomotive alone is braked. You all remember the sad accident the other day in the Rocky Mountains from this cause. But when all the wheels are braked, the train rests on an incline of 1 in 5. So also, if we had the power, we could ascend an incline of 1 in 5 by electrical motors.

Third.—As to advantage to permanent way and speed. The engine does not give a steady pull at all times to all parts of the train. In fact, in going round a curve, part of the engine's power is used up in trying to pull part of the train off the lines. With power applied to all the wheels, this would not be so. Moreover, the enormous weight of the locomotive, imperfectly balanced, which is the chief source of mischief, would be done away with.

Fourth.—As to cost. The cost of making an ordinary railway line with tunnels, embankments, bridges, viaducts, &c., in England may be taken at £15,000 a mile; but if it goes up inclines instead of having expensive engineering works, the cost will be the same as making it on a level, *i.e.*, £5,000; and hence, on a goods line, the cost of construction might be reduced to one-third. This original outlay is a far more serious matter than the working expenses of a railway (of which the cost of the traffic is 26 per cent.); so that, even if by using electricity you increased your working expenses, you might still be making a great saving on the whole. On fast passenger trains, the power to drive your trains at twice the speed would counterbalance any small loss of economy. Again, there would be a great saving in the cost of maintenance of permanent way.

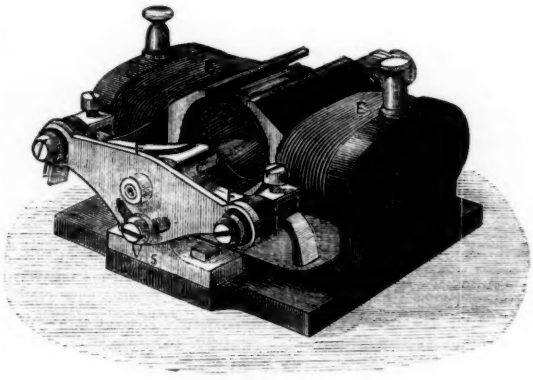
There are many cases where such an application of motive power would be peculiarly satisfactory. The most important of these is the Underground Railway in our city. It is now universally admitted that steam locomotives vitiate the air to an intolerable extent. If motive power were used electrically, this evil would be avoided. Moreover, a line like this, which is almost totally underground, and is comparatively unaffected by snow or rain, possesses exceptional advantages for electric insulation. But the system which I have advocated would introduce special advantages to this line. What are the conditions of working? The distance between stations is so short that a great deal of time is wasted in getting up speed and stopping the trains. The latter evil, it is true, has been reduced to a minimum by the adoption of continuous brakes; but you will understand how much speed is limited by the former consideration, when I tell you that an ordinary train cannot get up a speed of thirty miles an hour until it has passed over a quarter of a mile, just about the distance between some of the stations. If the system I propose were adopted, of applying motive power to every wheel, the same speed would be attained in forty-four yards.

The Channel tunnel, when completed, will be specially favourable for the insulation of conductors. But the system which I recommend could not be adopted, as the great advantage of the tunnel is that the same waggons will go right through without any transference of goods. In this case, if electricity be used as the motive power, it would be necessary to use it to drive a heavy locomotive.

I think I have now said enough to prove that a great deal has already been done, and that we may reasonably expect a great deal more to be done in the use of electricity as a motive power. Water-power has been usefully employed in various installations to obtain electricity, and the current has been successfully conveyed several miles, to be reconverted into motive power with great economy, and electric railways have been successfully and economically worked at several places. I have not thought it right in this paper to indulge in Utopian dreams of what may be done in the future, however pleasant such an exercise of the imagination might have been. I have thought it to be more useful to look at the matter from a practical point of view, and to estimate our present position with respect to this force, and to indicate the steps which our past experience would warrant us in taking in the immediate future. I should like to see a larger number of our wealthy compatriots experimentalising in this field, so as to keep our country in the front rank of the applications of electricity, as she always has been in those of steam. But we must go on step by step—learning from every fresh experiment, and utilising experience for further advances. We must not hope to reach perfection at one bound. The development of this most potent of agencies must in the nature of things be gradual. We must have patience, but at the same time we must work and labour to our utmost, and take a step onwards wherever that step is sure, and in due course we shall be ourselves astonished at the progress which has been made.

M. ESTÈVE'S MOTOR.

"M. ESTÈVE sends us the following note," says *La Lumière Electrique*, of May 26th, "concerning a little motor, or dynamo-electric machine," shown in the accompanying figure :—



"From the numerous experiments which I have made on small dynamo and magneto-electric machines with one coil, I found it advantageous to furnish the inducing electro-magnet with an expansion and to suppress it in the Siemens coil ;* the induced part has then the form of simply a flat electro-magnet. Better results are obtained by forming the core of the induced part of thin layers of sheet-iron, insulated one from another by sheets of paper ; but it is yet preferable to employ a hollow core formed of insulated sheets. By employing induced coils with a hollow core, the best results are obtained with bobbins constructed according to the rules laid down for the manufacture of tubular electro-magnets : the sides should be rather thick, for, if they are too thin, the yield is diminished and reduced to that obtained with induced coils without iron in their cylinders. I have also constructed coils the cores of which were formed of insulated iron wires, but did not obtain better results than with the hollow cores formed of insulated plates, which mode of construction I have adopted in my machines, and by which we obtain all the advantages of iron without its drawbacks, provided that there is no remaining magnetism, and that the magnetisation and demagnetisation can be effected with the greatest speed.

"I have tried to simplify as far as possible the construction of the machine : the inductor, of gray pig-iron, serves as a framework ; and this comparatively large mass of iron increases the power of the magnetic field, and the poles of the electro-magnet act as directly as possible on the induced part.

"When a somewhat powerful current has been sent into the machine, the inductor remains sufficiently magnetised, and the motor then presents the advantages of the magneto-electric machines without their inconveniences ; by employing it as a generator of electricity, a rather powerful current can be produced when the inductor has been magnetised, whereas it gives a very feeble current when the magnetisation has not taken place.

"The induced coil is placed in series, and with powerful currents there are no sparks at the bobbins.† This machine thus arranged was placed in derivation in the circuit of a Gramme machine (working type) ; it did not become at all heated and there were no sparks at the bobbins. I have found that with iron commutators, which are very durable, there are much fewer sparks than with copper ones and the rendering is not diminished.

"In order to avoid the dead point, an armature can be used formed of four coils of the same length and diameter as the simple bobbin ; to construct more powerful machines, a greater number of bobbins are put on to the induced part."

* The opposite arrangement has been recommended by M. Marcel Deprez (*La Lumière Electrique*, vol. i., p. 389). With the expansion on the inductor, we get a more powerful magnetic field ; and by suppressing it on the bobbin, we obtain a lighter coil turning with much greater rapidity.

† M. D'Arsonval, however, advises that the bobbin should be placed in derivation, but this arrangement has not given me good results.

NOTES.

To our Readers.—We have again to leave over numerous late letters and articles owing to want of space. We would ask our Correspondents to kindly state their views in terms as brief as is consistent with the subject dealt with.

Electric Lighting.—Our case-room has been during the past two weeks successfully lighted by electricity. The lights used are incandescent lamps, and the electricity is supplied by the Faure-Sellon-Volckmar accumulators. The installation has been fitted up by the Brush Electric Light and Power Company of Scotland (Limited), of which Mr. Duncan, Adelphi House, Aberdeen, has been appointed local agent. The light is exceedingly pleasant in colour, and perfectly steady, less trying to the eyes than gas, practically exempt from heat, and innocent of the deleterious results of gas burning, the atmosphere remaining perfectly sweet and wholesome however long the lights have been burned. The electricity is stored by one of the engines used for the printing machinery, during the intervals between the publication of the editions of the *Evening Express*, and the accumulators, as so charged, keep the lamps burning brightly all night without needing to be replenished. This is due to the fact that when the Faure-Sellon-Volckmar accumulator is properly used, the effective return of the electricity on circuit through the lamps is 90 per cent. of the electrical energy that has been stored. The accumulator effectually gets rid of the unsteadiness that has hitherto been complained of in using lights directly dependent on machinery, any fluctuation in the speed of the motor producing a corresponding fluctuation in the steadiness of the light. With the accumulator, moreover, there is no risk that any sudden excess of current may destroy the carbon filament of the lamp, and no liability to such disturbance as the slipping of a belt or the loosening of a screw, which may produce immediate darkness. The accumulators recommend themselves, moreover, as possessing "the enormous advantage of only yielding up the quantity of electricity actually consumed by the lamps alight at the moment, whereas when lighting is done direct from a dynamo, if part of the lamps are put out, an equivalent resistance must be inserted in order to prevent the breakage of the remaining lamps. Notwithstanding the extinction of, say, 90 per cent. of the lamps, the expenditure of the motive power would remain virtually the same as when the whole lamps were alight."—*Aberdeen Journal.*

In the House of Commons on Thursday week Mr. Shaw-Lefevre, in answering Mr. Coope, said he was still of opinion that they did not know enough of the electric light to justify him in putting pressure on the Trustees of the National Gallery to light that gallery with electricity. There were, however, other objections to lighting the galleries at night.

That the electric light should form part of the fittings of vessels of any importance built on the Clyde is now accepted as a matter of fact, and it would be easier to record those not fitted, than those fitted with the light of the present.

After an extended trial of the electric light, Messrs. Shepherd & Beveridge, Floorcloth Manufacturers, Kirkcaldy, have decided to permanently light their extensive premises by Edison incandescent lamps.

The s.s. *Adelaide*, now finishing at Messrs. D. and W. Henderson & Co.'s yard, Partick, near Glasgow, is to be lighted throughout with the incandescent system. The work has been intrusted to the Edison Electric Light Company which, with a single exception, has now in hand all the electric lighting on Clyde shipping.

At a meeting of the Leeds Committee, this week, it was reported that several communications had been received from companies and persons desirous of tendering, suggesting

for the consideration of the committee the desirability of the clause in the particulars issued on the 21st ult., relating to the employment of a particular type of dynamo machine being modified, and after the subject had been considered it was resolved that the committee conclude to modify the clause so as to allow companies and persons tendering to suggest for use such types of dynamo machines as they may consider best adapted for employment in connection with the particular system of lighting comprised in the tender. It was also resolved that "the committee will, at their own cost, open in the walls and other places such receptacles as may be necessary to receive interior wires, and that after the contractor has placed the wires in position the committee will cover up and make good such receptacles, and will also cover with wood mouldings such wires as may be exposed, or which may require protection." Also, in regard to incandescent lamps "Swan or other approved lamps of not less than 20 candle-power must be used."

Major Marindin, on behalf of the Board of Trade, held an inquiry this week in Edinburgh regarding an application which had been made by the Electric Brush Light Company of Scotland for a Provisional Order for a specified area in that city. He said it was the first inquiry under the Electric Lighting Act. It embraced the questions of capital, area, and the ability of this company to carry out the works which they proposed to construct. Several witnesses having been examined, Major Marindin stated his intention of reporting against the preamble of the Bill, on the ground that the company had failed to make out their case.

Part of the Gaiety Theatre, London, is to be lit with the Swan lamp. The work is being executed by Mr. H. Bury, 46, Market Street, Manchester, who, we believe, is also to light the Princess's Theatre of that city.

We understand that the result of the 9 months' trial of the Fyfe-Main arc lamps in the establishment of the *Daily Telegraph* is five times the amount of light at a cost of 15 to 20 per cent. below the price formerly paid for gas. In one instance where two of the lamps replace 216 gas jets the saving is very great, but the figures we have given above is the average result obtained with 16 lamps. The work of the journal is of course carried on under greatly improved conditions.

The chemical works of Messrs. Barnes & Co., Hackney Wick, are lighted by one small Lumley dynamo with sixty 20-C. P. incandescence lamps.

Advices from America state that the United States Electric Lighting Company has completed arrangements for lighting the Brooklyn bridge. Seventy lamps are in place and the circuits are ready for the current. We also note that a high wind at Fairfield, Ia., blew down the electric light tower on May 9th, completely demolishing it. It was an Elgin tower, 175 feet high, and had six Brush lamps on it of 2,000 candle-power each. The tower fell across the Western Union Telegraph wires, tearing them down for a quarter of a mile.

The station of Vento, Holland, has been entirely lighted by Brush lamps by the Compagnie Belge et Hollandaise d'Electricité, Brussels. The motive power is supplied by two engines made by Messrs. Fowler & Co., Leeds, of 25 horse-power each, a third engine of the same construction being held in reserve.

We understand that Major Marindin the officer appointed by the Board of Trade, has made his report on the inquiry held at Westminster on the 10th May, and that, as regards the St. Giles' district, a Provisional Order has been granted to the Pilsen-Joel and General Electric Light Company (Limited), by arrangement with the local authorities. The area to be lighted will be the south side of New Oxford Street, High Holborn, from the centre line thereof, extending from Tottenham Court Road to Little Queen Street, and the houses, premises, and buildings abutting thereon; and an area bounded on the north by the centre line of High Holborn from Little Queen Street to the boundery of the parish of St. Giles in the Fields; on the east by the said parish boundary line; and on the south by the houses on the north side of Lincolns Inn Fields, and the houses on the south side of Twyford's Buildings; and on the west by the houses on the west side of Little Queen Street.

The Pilsen-Joel Company has already established a lighting station in that area, and has been for some time past successfully lighting large business establishments from this central station.

At the Fisheries Exhibition Messrs. Woodhouse and Rawson have arranged to light up the grand vestibule at the entrance with between three and four hundred of their incandescent lamps. Lord Elphinstone and Mr. Vincent are exhibiting their dynamo to supply current to these lamps. Mr. Charles Lever has an installation consisting of twenty-eight 2,000 nominal C. P. lamps, two special compound Gramme machines, and two B Bürgin dynamos excited by an A Gramme. The lamps are worked on four circuits with one larger return cable, and are arranged as follow:—Eight in the dining-saloon and eight in the luncheon and tea room. These are worked by the two compound Grammes, and are alternately arranged so that in case of belt slipping off, or any accident happening to one of the machines, each alternate light goes out. Four in the fish dining-room, one in the fish kitchen, two in the lecture theatre, two in the fine art room, three in the kitchens. These twelve are worked by the two Bürgins, which are separately excited by the A Gramme and are also alternately arranged as far as practicable, although in the fish dining-room two lamps on one side of the room are on one circuit, and the two on the opposite side are on the other circuit. With this exception they are alternately arranged. The E.M.F. required for each lamp is from 30 to 35 volts, and the current from 12 to 15 ampères. Mr. Mathiesen will light the corridor of the royal pavilion with four of his arc lamps, and will also place one in the shipwrecked mariners' home, and one or two more in the engineering department sheds. The lamps will be fed from his own dynamo machines as used at the Royal Aquarium recently. The Gülcher Company exhibits 600 Crookes' incandescent lamps in the China, Japan, and Straits' Settlements departments, and 30 Gülcher arc lamps in the machinery and dynamo-houses, all being run from four Gülcher low-tension dynamo-machines.

Messrs. Laing, White, and Wharton are running a temporary installation of between 40 and 50 Swan lamps of 10 candle-power each at a fancy fair, St. Peter's, De Beauvoir Square, N. As the bazaar is held in the crypt of the church it is quite dark at midday, and the current is therefore turned on from 3 o'clock till 10·30 or 11. The source of current is a set of 54 cells of the Duplex Company's primary batteries, such as were used on board the *Rainbow* during the entertainments given a few weeks since by the naval volunteers and to which we alluded at the time. The work at St. Peter's has been carried out under the personal direction of Mr. C. J. Wharton.

Electric Lighting at Buenos Ayres.—At the general meeting of the shareholders in the Buenos Ayres (New) Gas Company (Limited), held on Tuesday last at 1, East India Avenue, the Chairman, Sir Wilford Brett, stated that the past year had been one of great anxiety to the executive officers of the company, in consequence of the endeavour to introduce the new system of lighting by electricity. The prevalent opinion as to the result of the experiments tried seems to be that though the light was beautiful to behold and adapted to large areas such as the Plazas at Buenos Ayres, yet it seemed to lack that steadiness and continuity which so perfectly marks its rival gas. The matter of cost has still to be overcome, and so far as could be ascertained it did not seem to have exhibited any conviction as to its superiority in the public mind. Further experiments in this direction were still in contemplation, and additional plant had arrived, but up to the present there was not much cause for fear.

A Timely Warning.—The experiences of the West India and Panama Telegraph Company afford, says the *Pall Mall Gazette*, a timely warning to investors. Its prospectus set down the estimated revenue at £156,000. The company has been at work and tested the truth of the estimate. The result is that the revenue, under presumably energetic management, yields only a bare £50,000, or less than one-third of the promises of the promoters.

Telegraph Extension in Shetland.—Mr. James Tulloch, jun., of Aberdeen, who for years has greatly interested himself in the development of the fishing industry in the north, and who is at present in London, acting on a suggestion of several of the larger merchants and traders in the Shetland Islands, over which he has recently travelled, is in communication with the postal authorities on the subject of the extension of the telegraph to the outlying stations there. Last year it was understood to have been practically arranged that the telegraph would be extended to Hillswick, Ollaberry, and some of the other outlying stations. For some reason or other the project appears to have hung fire, and efforts are now being made to get the scheme carried into effect. The representations to the postal authorities point to the fact that one of the best fishing stations in the whole of Scotland is to a large extent left untouched, and that better telegraphic facilities would greatly serve to develop it. In spite of all disadvantages the industry is increasing, and this year it is expected that no fewer than 800 boats will take up their quarters there.

The Wheatstone Automatic Telegraph.—Mr. S. H. Strudwick, of the Wheatstone staff, was in Pittsburg on April 27th, introducing the system there. Mr. Strudwick, says the *Operator*, is sanguine of the future of the Wheatstone method. He says: "Its merits have been often acknowledged, but it has needed the backing of some great corporation like the Western Union to push it forward into the success it surely merits. I am well satisfied that the present experiments will prove sufficiently satisfactory to the Western Union to warrant that company in adopting it for general use. Indeed the fulfilment of that hope might be prognosticated from the fact that the leading officers of the company are interesting themselves in the experiments, and have furnished me with through wires for making experiments."

The Patents for Inventions Bill.—Mr. Chamberlain, in reply to a deputation, stated that when the Patents for Inventions Bill came before the Grand Committee on Trade matters of detail would be thoroughly sifted, and the Government would be prepared to accept such amendments as commended themselves to the majority of the Committee. As to the question of fees, he could not admit that they were bound to assert as a principle that the fees should in no case cover more than the expenses of the office. It was provided in the Bill that hereafter the fees might be diminished at the instance of the Board of Trade by means of a mere Parliamentary resolution. As to the method of the payment of the fees—whether they should be paid in three several payments or annually—any annual payment to which he could assent would make the real payment larger than he intended it to be. For instance, in order to obtain the £150 required, £11 annually for fourteen years would have to be paid. The poorer class of inventors, who, under the Bill would get a four years' patent for £4, would not be able to pay £11, or perhaps even £5 per annum. Dealing with the proposed duration of a patent, he said the feeling of the House of Commons was adverse to extending it. Lastly, there was the question of the Government claim to inventions, which was merely a re-stating and renewal of the claim already established by the great departments of the State, especially the Army and Navy, and that was based upon considerations of public security and public interests. He suggested to the deputation that they should lay their views on this subject before the Admiralty and the War Office.

There is a rumour that the Government Patent Bill will not become an Act this Session, owing to the pressure of business, and that a much-needed measure of reform will be shelved for the present, at all events. A reform in the Patent Laws, or at least in the fees payable for protection, says the *Echo*, is as much needed as technical education; and if the present opportunity is allowed to slip, inventors—especially poor inventors—will know that they have little to hope for from either Liberals or Tories. One has only to inquire amongst the more intelligent artisans to discover that the present high scale of fees is acting as the "wet blanket" on invention, and that it is useless to expect anything like the development of new ideas which we see in the United States, until such protection as is afforded by a patent is brought within the reach of the poorest working man.

The Shock from a Weston Machine.—We read in the New York *Electrical World*, that a short time since one of the line-men employed by the Citizens Electric Light Company, of Toledo, O., which is running a central station supplying something over one hundred Weston arc-lights, received a shock from two twenty-light machines coupled together and supplying a forty-light circuit. He was making some change in the adjustment of one of the lamps, and took it out of circuit just before the time for starting up in the evening. Before he placed it in position again the current had been turned on without his knowledge, and he accidentally took hold of both terminals of the circuit and received the current from the two machines. The shock was so severe as to close his hands on the wires, and he fell from the step-ladder on which he was standing, his weight tearing him from the wires. His hands were somewhat burned, but he did not lose an hour's time from his work, and suffered no other injury or inconvenience.

Death of an American Electrician.—Mr. William E. Sawyer, a well-known electrician and electric light engineer, died at his residence in this city on the 15th inst. Mr. Sawyer will be remembered as one of the pioneers in the field of electric lighting in America. According to the *Electrical World* of New York he achieved fame and fortune at an early date. It is said that his inventions formed the basis of the first electric light company in America—the United States Electric Light Company—who retained his services on a contract of several years, at a munificent salary. Mr. Sawyer only remained a few weeks, however, and then threw up his contract. It is said also that the $50,000 which he received for his inventions soon disappeared. He then gave his attention anew to electric lighting, and a new company, the Sawyer-Mann Electric Light Company, was formed to operate his incandescent system. It appears that he was at work on an incandescent system much sooner than Edison or Maxim, and that he was successful in contests with them for priority in the patent office. In the beginning of 1881 Mr. Sawyer published a book on "Electric Lighting by Incandescence," which, for a time, was the best work on the subject. The Sawyer-Mann Company did not live long, and Mr. Sawyer started one or two other companies, which shared the same fate. As an electrician, Mr. Sawyer belonged to the practical school rather than to the scientific. His inventions are not so remarkable for originality of conception as for ingenuity of application. In a word, his genius was constructive rather than creative.

Overhead Wires at Brighton.—Since the introduction of the electric light and the telephone into Brighton, a large number of overhead wires have been erected, and an interesting Town Council discussion is now going on as to whether or not they are to be allowed to be continued. The matter, apparently, will only be settled by the law.

The United Telephone Company (Limited) *v.* The Long-Distance Telephone Company (Limited).—In the Chancery Division of the High Court of Justice, on Friday of last week, Mr. Justice Chitty again had under consideration the motion by the plaintiffs for an interim injunction to restrain the defendants, until the trial of the action, from using, manufacturing, or selling instruments made according to certain patents for telephonic instruments patented by one Hopkins, which were claimed by the plaintiffs to be within the well-known Bell and Edison patents. Mr. Aston, Q.C., and Mr. Moulton were for the plaintiffs; and Mr. Macnaghten, Q.C., and Mr. Davenport for the defendants. It was arranged between the parties that, without prejudice to any question in the action, the defendants should give an undertaking in the terms of the notice of motion, and the plaintiffs should give an undertaking in damages.

The Rival Telephone Companies.—Before Mr. Justice Pearson, in the Chancery Division of the High Court of Justice, on Friday of last week, Mr. Hemming, Q.C., and Mr. Beale moved to discharge an order for an injunction made on the 22nd ult., restraining the London and Globe Telephone and Maintenance Company from interfering with the telephone or telegraph wires, instruments, or apparatus belonging to the United Telephone Company. It was stated that out of the 15 cases in which the defendants were said to have interrupted the plaintiffs' business by the mode of hanging their wires, 14 of such cases arose from the wires accidentally shifting their position so as to touch the wires of the plaintiffs, and thereby to prevent effectual insulation of the wires. But with respect to the 15th case, in which the wires had been tied together with a band, the defendants admitted they had done this for the express purpose of asserting their right, as opposed to the plaintiffs, of using the place taken by them. After some discussion Mr. Justice Pearson directed that the engineers of both parties should co-operate for the purpose of freeing the plaintiffs' wires from obstruction in the 14 instances, and he should continue the injunction as to the 15th instance brought forward until the following Thursday, unless the engineers could co-operate in arranging the wires in such a manner as to cause an insulation of the plaintiffs' wires. At the Guildhall Police Court, on Thursday of last week, Theodore Torrey, manager of the Globe Telephone Company, and William Goodfellow and James Molyneux, two men working under him, appeared to an adjourned summons taken out against them by the United Telephone Company, for wilfully and maliciously tying up their wires. Mr. J. P. Grain appeared for the United Telephone Company, and Mr. George Lewis for the defendants. Mr. Lewis said the United Telephone Company had made an application to the Court of Chancery since the last hearing of the case in this court, and, therefore, as the case was *sub judice* in a civil court, criminal proceedings ought not to be allowed to go on until the civil proceedings were settled. Mr. Grain said that was not exactly the case, for the criminal proceedings were against the defendants and the civil proceedings in the Court of Chancery were against the company as a company. Sir Robert Carden said he thought the two proceedings were so mixed up that they could not be separated. He did not feel that he could go on with a criminal case while civil proceedings were pending, and he therefore suggested that the wires should be untied. Let the companies fight out their battles without giving any inconvenience to the public. After a long argument between counsel, Sir Robert Carden remanded the case until after the decision in the appeal by the Globe Company against the injunction obtained against them by the United Telephone Company was known.

The General Post-Office Telegraph Department.—The additional storey which is now being put to this department will cost £30,000.

The Globe Telegraph Code.—This new code, by Mr. E. Garsin, has now been published by Messrs. Dawson and Sons, 121, Cannon Street, E.C. It is a neat little volume of some 60 pages admirably printed and bound, and among the special advantages claimed for it are that it can be adapted in a few minutes to the special requirements of any trade; that it can be used for European and extra European messages, and that it is arranged on the two-letter difference principle, and in accordance with the rules of the Telegraph Convention. It is likewise said to be the cheapest code ever offered to the public.

Underground Telegraphs.—The Liverpool Chamber of Commerce met on Tuesday, when a letter was read from the Postmaster-General, stating that the question of extending underground wires, which had already been considerably developed, had been the subject of serious consideration; and the Department was using its best endeavours to gradually increase the number. At the same time, underground wires were as liable to disturbance from electrical causes as overground wires.

Walter T. Glover & Co.—This Manchester firm of electrical wire and cable manufacturers has opened offices at 85, Buchanan Street, Glasgow, under the charge of Mr. A. B. Spence, who will attend to the interests of the company in Scotland.

New Storage Batteries.—As a misapprehension has in some quarters arisen as to who is the patentee of the new storage batteries, manufactured by the Electric Carbon Storage and Apparatus Manufacturing Company of Scotland, Mr. Jackson, the manager of that company, intimates that the inventor is Professor Charles Forbes.

The Institution of Civil Engineers.—The annual *conversazione* was given on Wednesday evening by the President, Mr. James Brunlees, in the South Kensington Museum.

The Microphone.—M. E. de la Bedoyère (Controleur Principal du Télégraphe des Chemins de l'Est, à Paris), writing to a Parisian contemporary, mentions that M. Emile Christiaen thought to modify the Ader transmitter so as to render it applicable to the Blake microphone, and states that that was necessitated by the inconveniences of this last apparatus, which very frequently got out of order and required repairing. He gives a description of a mode of transformation which, he says, is much more simple, and which has been employed for a long time by the telegraphic service of the Chemin de Fer de l'Est. It consists in replacing the microphonic system of Blake by a system composed simply of a ring of cork, behind which is placed a grill of five carbons, of which two are fixed and three movable. By this method very satisfactory results have been obtained, these micro-telephones having worked for nearly a year without requiring once to be touched. M. E. de la Bedoyère advocates the employment of the cork membrane, which gives much greater clearness to sounds and speech than the deal disc. This assertion is supported by numerous experiments which have been made with membranes of various kinds.

Huddersfield Exhibition.—There will be displayed at the Huddersfield Exhibition, which is to be opened about the middle of next July, a miniature telephone exchange, a comprehensive assortment of Post-office apparatus, and codes of signalling historically complete from the days of Troy to the days of the heliograph.

On the Residual Current of Weak Electro-motors and the Constitution of Electrolytes.—By A. Bartoli.—If the current of a feeble electro-motor is allowed to pass through a voltameter and a galvanometer it decreases down to a small residuum, but does not disappear. From former experiments of the author it appears that the feebler the electromotive force and the smaller the surface of the electrodes (gold or platinum) the smaller is the residuum. It increases with a rising temperature. The smaller the resistance of the closing circuit the more rapidly the current decreases.

In more recent experiments with ten elements connected alongside of each other (which alone, according to theoretical calculation, could not decompose water) it appeared on introducing a rheostat (one of Siemens' construction and another rheostat consisting of a neutral solution of zinc sulphate between two amalgamated zinc plates, 40 square centimetres in size) and a voltameter formed of an inverted glass bell filled with dilute sulphuric acid (2 to 5 per cent.), with electrodes at distances of 1 to 2 centimetres from each other. The residual current decreases the more rapidly from the closing of the circuit the smaller the total resistance, and when this is very small it remains finally constant for a long time.

If in case of a very slight resistance the residual current after a long time (24 hours) has sunk to a certain value, J, and if the resistance is gradually increased up to a certain value, which must not be exceeded, and is almost equal to the metallic resistance, the residual current remains unchanged. If the electromotive force approximates to that

which theoretically decomposes water, the residual current decreases as the resistance increases. If the electromotive force is greater, Ohm's law applies, regard being had to the polarisation of the electrodes. The residual current, if two voltameters are used with electrodes of different sizes, is, if the resistance is small 24 hours after closing the circuit, proportional to the size of the electrodes. It increases rapidly with the electromotive force of the circuit, and with rising temperature. In concentrated nitric acid the same results were obtained with very feeble electro-motors. The addition of a small quantity (12 per cent.) of nitric acid to the solution does not much increase the intensity of the residual current, and after a short time it re-assumes its former intensity.

For the explanation of the phenomena we may assume that the substances separated out in the first moment at the electrodes are diffused, dissolved in the liquid, or excluded by the electrodes, or combine with the gases dissolved in the liquid, otherwise the current would sink down to null. The residual stream would be a measure for this distribution.

According to the experiments with the increasing resistance, R, of the circuit the polarisation of the electrodes, P, must decrease in such a proportion that (E — P) R remains constant, E being the electromotive force of the circuit; with the increasing surface, S, of the electrodes, P, decreases, so that (E — P) S R remains constant. Lastly, by increasing E the difference (E — P) must increase almost proportional to the fourth power of E.

We can also assume that for the decomposition of some of the molecules only, an electromotive force, $a\,Q$, corresponding to the theoretical quantity of heat, Q, is needed, but for some a smaller power between 0 and $a\,Q$, since single molecules are partially dissociated, according to the hypothesis of Clausius.

If M is the number of the electrolytes which touch the electrodes in the unit of time in their movements, and $f(q)$ the number of the partially dissociated molecules among them which require for decomposition a quantity of heat between q and $(q) + d\,q$, then

$$M = S \int_0^Q f(q)\, d\,q,$$

and the residual current-intensity, on using a circuit of the electromotive force, K is

$$J = a\,S \int_0^K f(q)\, d\,q.$$

If $f(q)$ is changed slightly when the electrodes are connected with the battery, J does not change notably with the time and the resistance, but it is proportional to the surface of the electrodes, and increases with their electromotive force. As J is almost proportional to q^4 the number $f(q)$ of the molecules in a certain state of decomposition $f(q) =$ const. q^3.—*Wiedemann's Annalen.*

Electrodynamic Method for the Determination of the Ohm.—Experimental Measurement of the Constant of a Long Coil.—By M. G. Lippmann.—The electromotive force employed in this method is produced by the relative displacement of two circuits, as in the well-known experiment of M. Kirchhoff. The total arrangements are almost the same as in the method of M. M. Lorenz.

A movable frame revolves around one of its diameters with a uniform velocity of n revolutions per second. It is placed in the interior of a fixed coil, traversed by a current of intensity i, which passes at the same time through the wire the resistance of which is sought. The induced circuit is closed only for an instant at the moment when the electromotive force passes by its maximum value, e; at this moment it is opposed to the difference of potential between two points, A and B, selected in the wire, so that there may be an equilibrium. The equilibrium is ascertained by means of a sensitive galvanometer. If we call r the resistance of the portion of the wire comprised between the right sections passing through A and B, S the surface enclosed by the induced wire, C, a constant peculiar to the coils employed, we have the following condition of equilibrium, which gives at the same time the value of r:—

$$r = 2\,\pi\,n\,C\,S.$$

The use of a frame carrying p coils of wire gives electromotive forces p times greater than if the disc of M. Lorenz had been used. The influence of the thermo-electric perturbations may consequently be neglected.

We know that the determination of C by calculation is so complicated that its approximate value is not easily indicated. I believe that we may avoid all calculation by operating in the following manner:—If we employ a fixed coil, infinitely long in proportion to its diameter, C would be known. We should have exactly—

$$C = \frac{4\,\pi}{d},$$

d being the mean distance between two turns of the wire. As we cannot construct a wire infinitely long, we may obtain an equivalent result. We place at the outset the movable frame in the centre of a fixed coil the length of which may be two metres, and obtain the points A and B, as has been said. Then, leaving the movable frame in its place, we bring the fixed coil into a second position, which is the prolongation of the former, and obtain thus upon the wire a new interval, B B′, placed in succession to A B. The small additional segment, B B′, is the elongation undergone by A B, when the inducing coil is prolonged by two metres. We may thus indefinitely elongate the inducing coil by means of the simple displacement of one and the same segment. We arrive very quickly at additional segments, which may be neglected with reference to A B. The determination is then completed.

It will be remarked that this method is most direct, requiring no calculation of reduction or correction. If the points of derivation, such as A and B, are needle-points, the final distance between the needle-points is the result sought, without any correction.

The method of experimental determination of C which has just been explained applies also to other problems beside the determination of the ohm. It may be used for the construction of a tangent galvanometer or an absolute dynamometer.

For this purpose we arrange a movable magnet or a movable coil in the centre of a fixed coil. The constant of the instrument is equal to

$$\frac{4\,\pi}{d} - \delta,$$

δ being the sum of the moments of deviation obtained by removing successively the fixed coil to infinity.—*Comptes Rendus.*

Influence of Temper upon the Electric Resistance of Glass.—By M. Jamin.—I have observed by means of a Lippmann's electrometer the variations produced in the resistance of tempered crystal and glass if they are submitted to a more or less energetic annealing. The specimens employed were small goblets, cylindrical or slightly conical, the two surfaces being in contact with sulphuric acid. Mercury was used instead of the acid when operating at temperatures higher than 80° C., as the vapours of sulphuric acid produced a superficial conductivity by being deposited upon the glass.

After a first series of determinations the specimen was immersed in a sand-bath, kept for a certain time at a temperature more or less elevated and then cooled slowly. A new series of determinations was then executed at the same temperatures as the former. The time necessary for charging a condenser to a given potential serves as a measure for the resistance of the specimen. The experiments have led to the following results:—

1. Tempering diminishes to a considerable degree the electric resistance of different glasses. In a specimen of tempered glass with a base of lime, annealed for six hours at 500° C and observed between 35° and 80°, at every 5° the original resistances have been respectively multiplied by 2·30. In tempered crystal the variations are still more striking. Whilst the resistance becomes eleven times greater for tempered crystal, it remains almost stationary for untempered specimens.

2. Moderate annealing, capable of partially removing the elasticity due to tempering, only destroys in part its action on the electric resistance. A specimen of tempered crystal was heated to 260° and then slowly cooled. Its resistance increased in the proportion of 1·8 to 1. The same specimen

heated to 400°, and kept at that temperature for two hours, took a resistance 7·2 times greater than the original resistance.

3. The resistance of a glass recently annealed continues to increase slowly for some time, as if approaching a state of definitive equilibrium. The resistance of a glass, tempered or not, which has not been heated for a long time, remains invariable.—*Comptes Rendus.*

On the Electrolysis of Binary and various other Acids and Saline Compounds with Electrodes of Carbon.—By A. Bartali and G. Papasogli.—In all cases where no oxygen is evolved at a positive electrode of retort-coke, wood-charcoal, or graphite, it does not become disaggregated and undergoes no notable loss in weight; *e.g.*, in the electrolysis of concentrated hydrochloric and hydrobromic acids, or solutions of bromide or iodide of potassium.

If oxygen is evolved at the positive electrode, as in the electrolysis of dilute solutions of the above-mentioned salts and acids, solutions of arsenious acid of various degrees of concentration, cold concentrated solution of boric acid, dilute sulphuric acid, sulphates, oxalates and formiates, strong solutions of hypochlorites, permanganates, bichromates, alkaline chlorates, nitric acid, pyrogallic acid (although it eagerly absorbs oxygen), a positive electrode of coke or wood-charcoal is disintegrated and the liquid takes a deep-brown colour with formation of mellogen. In solution of sodium sulphate this does not occur. A positive electrode of graphite yields graphite acid, but the solution is not coloured.

In strong solutions of hydrofluoric acid a positive electrode of coke is scantily disaggregated, but becomes brittle; little hydrogen is liberated at the negative pole. After some time the positive electrode, if powdered and washed for some time, still retains hydrogen, oxygen, and fluorine. A positive electrode of graphite quickly crumbles away, and the powder formed retains fluorine even after prolonged washing. In solutions of potassium antimoniate a positive electrode of gas-coke or wood-charcoal quickly wears away; the solution becomes black and deposits a precipitate soluble in water. After filtration and concentration hydrochloric acid gives a precipitate, containing carbon, hydrogen, oxygen, and antimony, and is named stibio-mellogen. Graphite is disintegrated and yields a black powder consisting of graphite and a new antimoniferous compound.—*Wiedemann's Beiblätter.*

OFFICIAL RETURNS OF ELECTRIC COMPANIES.

Edison Indian and Colonial Electric Company (Limited).—The first return of this company, made up to the 5th of October, was filed on the 25th ult. The nominal capital is £250,000, divided into 40,000 A and 10,000 B shares of £5 each. 24,482 shares have been allotted, and £1 10s. per share has been called thereon, the calls paid amounting to £34,637, leaving £2,086 unpaid. Registered offices, 4—6, Throgmorton Avenue, E.C.

CITY NOTES, REPORTS, MEETINGS, &c.

The Consolidated Telephone Construction and Maintenance Company (Limited).

THE second ordinary general meeting was held at the Cannon Street Hotel on Thursday, Sir Julius Vogel, K.C.M.G., the Chairman of the Company, presiding.

The Secretary (Mr. Charles Curtoys) having read the notice convening the meeting,

The directors' report was taken as read. The revenue for the year ending March 31st, 1883, shows a credit balance of £5,789. The directors do not recommend the payment of any further dividend for the past year, the operations of which have in many respects been very disappointing. The accounts show scarcely any transactions with the United Telephone Company, but since the expiration of the financial year a satisfactory arrangement has been come to between the two companies, in connection with which the United Telephone Company have relinquished to the Consolidated Telephone Company the benefits of an agreement which the former company have entered into for supplying telephones to the Post Office. The directors have entered into engagements in relation to telephone concessions in Austria, some of which are already in active operation. The directors regard most favourably the interests which the company has in the River Plate Telephone Company. Probably few telephone companies have a better future before them than the River Plate Company. Embarrassed from want of capital, and with the danger before them of possibly having, in consequence, to sacrifice valuable interests, the directors had to determine to dispose of some of the unissued shares, and the market value left them no option but to do so at a discount. The financial difficulty is now surmounted; but the directors do not think it desirable to devide at present the money that is to be received from the United Telephone Company. When, as it is shortly proposed to do, the Austrian concessions are placed on a separate footing, a further division of profits will be fairly a matter for consideration. A considerable number of instruments are being sent to Australia, India, Egypt, and other parts of the world, under arrangements with the Oriental Telephone Company. With large connections abroad, and friendly relations with the United Telephone Company, the monopoly the company enjoys should yield it good returns in the future.

The Chairman in moving that the report and balance-sheet be adopted, said he would trouble them with a few remarks. His task that year was a very much less pleasant one than it was at their first ordinary general meeting, when they had nothing but favourable accounts of what had taken place and favourable anticipations for the future. Not one of the shareholders could have been more surprised than he had been at the unfavourable turn which the affairs of the company had taken during the past year. When he left for Australia in May of last year, he considered, as far as it was possible to judge, that the company was in a most prosperous condition, and when he returned he found that a variety of circumstances had occurred which had exercised a most depressing influence upon the fortunes of the company. Let them not suppose for one moment, however, that he wished to imply that his absence had anything whatever to do with these changed circumstances; he had no reason to say that had he been present the position of the company would have been different. The circumstances which affected the course of prosperity which they seemed to have entered upon were generally the following:—Under advice the directors, after a great deal of consideration, deemed it expedient to make a compromise in regard to a large claim which the company had for the manufacture of telephones. In June last the Post Office authorities, very much to their surprise, gave them notice of ending the contract they had with the company for 15,000 telephones. A power, he should explain, was left with the Post Office authorities that on a particular day they could annul the contract. They had no reason, however, to believe that they intended to adopt such a course, and it was not until the afternoon of the day that they received notice to that effect. One of the main objects of the company, as they were aware, was the manufacture of telephones for the United Telephone Company and its affiliated companies; and the United Company and its affiliated companies had really, as he believed, legally and legitimately against all comers, a monopoly of the use of the telephone in Great Britain and Ireland. Owing to circumstances which it was quite unnecessary for them to refer to, they had during the past year done no work worth speaking of for the United Telephone Company, and that was one of the variety of causes which had exercised the depressing effect to which he had referred. He might also say, though he would not put it into the category of depressing causes, that one of the causes which made it necessary for them to seek to raise more capital was, that the directors considered it expedient to enter into large engagements for carrying on telephonic business in Austria. He would briefly refer to these points in succession. As regarded the compromise there was little or nothing to be said. The directors considered it desirable and wise under all the circumstances to follow the course they did. The Post Office contract was, he was glad to say, in a sense restored to them. That was to say, it appeared that before the Post Office gave them notice of dissolving the contract it entered into an arrangement or contract with the United Telephone Company to supply it with instruments in place of those they were to take from this company. On representations being made to the United Company that the benefit of the contract ought to belong to this company, they acceded to the request made, and he might say that that company had agreed—the agreement was now in course of committal to writing—that this company should have the benefit of that contract so far as supplying the Gower-Bell telephones was concerned; that was the full profit from those instruments on the same footing as they would have had it had they contracted with the Post Office authorities direct. Cordial relations, he thought, he was glad to say, had already been established between this company and the United Company. A considerable sum of money had to be paid to this company in consideration of instruments which the United Company had had in recognition of their right to have supplied them and an agreement had been made in reference to future supplies. Seeing the vast scale upon which the business of the United Telephone Company was carried on and the prospects which he considered lay before that company in the future, he thought they might attach the greatest possible importance to the fact that they had restored relationship with that company, and that they were in the future to supply them with telephones.

Mr. Stoop: On the same terms as formerly?

The Chairman: On the same terms as in the original contract. The Austrian business had taken up a considerable amount of means, but as far as they were able to see the Austrian concessions were of very great value and that business was likely to turn out from a telephonic point of view a very profitable business. In other words, the Austrian towns were likely to be very large users of the telephones, larger users than this country, because part of the terms of concession enabled the use of the telephone for messages on the same principle as telegraph messages here. As they knew, the Post Office authorities had jealously objected to such a system, on account of the large capital the Government had put into the telegraph business. Without entering into particulars, he might say that there were some questions now pending in relation to title and cognate subjects with the Austrian concessionaires, which gave him some uneasiness, but he was in hopes that some satisfactory arrangements might be made, in which case they might fairly consider that they should derive considerable benefit from their Austrian arrangements. It was the intention of the directors, unless they saw their way clearly to benefit

themselves, not to go on under the proposed conditions. They had a very large interest in the River Plate Telephone Company, but that did not give them uneasiness, because, as far as they could see, and they had taken the best means of ascertaining, the telephone business of the River Plate Company promised to be as good a telephone business as was to be found in any part of the world. Not only were they making satisfactory progress in Buenos Ayres, but they had established a telephone exchange in Monte Video. They had obtained a concession, which, he was told, was a favourable one, to enable them to lay a telephonic cable between Monte Video and Buenos Ayres, which, if the terms were reasonable, might be of very great value to them. The company was contemplating extending the business to other towns. The River Plate Company was, he considered, very prosperous. It would be necessary for the company to issue further shares, and he should counsel them in their own interests and in the interests of the Consolidated Company, if the opportunity arose, to support the River Plate Company by taking up some of its shares. He thought they might consider the investment as one which would be likely to prove exceedingly remunerative. As regarded the future business and prospects of the company, he had only to say that he was still hopeful that they should make the company a success; the directors would spare no pains to do so. It was not pleasant to come before shareholders with less pleasing results than had been prognosticated, but the directors could not accept any blame. They had worked hard and had done their best for the company. The prospects of the company had no doubt greatly improved during the last three months. He was still sanguine that they should do a large manufacturing business in the way of supplying telephones for use in the United Kingdom and also to their numerous clients in different parts of the world. He concluded by moving the adoption of the report and statement of accounts.

Mr. Carnegy seconded.

In reply to questions by shareholders,

The Chairman said when they went to Buenos Ayres the River Plate Company was in full operation. It was not graceful to say anything reflecting upon rival companies, but he thought he might state that the Pan Telephone Company had not been a success. It had made a variety of offers and suggestions to them for amalgamation, but the directors had never seen their way to accede to the terms it proposed. The Post Office was using the Gower-Bell telephone, and he thought he might say it was considered by the authorities as almost a perfect instrument. He did not think it would be advisable for him to explain the difficulties they had with the Austrian Concessionaires. The prospectus of the River Plate Company showed the conditions under which they went to work with it. For their rights they received £20,000 in deferred shares and a very large contract for telephones. Their transactions with that company gave them no uneasiness. In regard to the Edison-Gower-Bell Company, it was considered expedient by the directors, after very long negotiations, to place their interests and the Edison interests all over Europe in one company—in the Edison-Gower-Bell Company of Europe, He could not say that that company had yet made much progress but it possessed what he considered was a very valuable concession in Portugal and had exchanges at work at Lisbon and Oporto which promised to be very successful. That company had offices at 34, Wallbrook, and any shareholder who desired further information in regard to it he should be happy to meet there. The amount they had to receive from the United Telephone Company was £5,800. He could not say when another dividend would be paid. When they placed the Austrian company under a separate management, as they hoped to do shortly, and when the Plate Company was in a position to discharge its liabilities to them, there would be no reason why the directors should not consider the question of making another interim dividend. Considering that the company was not paying any dividend, the directors were not drawing any fees. (Hear, hear.)

The report and accounts were unanimously adopted.

Messrs. Deloitte, Dever & Co. were re-elected the auditors for the ensuing year, at a remuneration of 50 guineas.

This concluded the business and the meeting separated.

London Platino-Brazilian Telegraph Company (Limited).

MR. JOHN PENDER, M.P., presided on Thursday, at noon, over the fifth ordinary general meeting in connection with the above company, at its offices, 66, Old Broad Street.

The Secretary, Mr. Wm. Payton, having read the notice convening the meeting, and the minutes of the previous meeting,

The Chairman said: Gentlemen, I suppose you will take the report and accounts as read? ("Agreed.") There is not a great deal to put before you beyond what is stated in the report. Still there are always some items which it is desirable to put at greater length before the shareholders. During the first three years we have paid regular dividends of 2½ per cent. per annum, and the dividend we recommend to pay is at the same rate, namely, 3s. (final), 2s. 6d. having been paid in November last. We wish to keep up that standard dividend as far as possible, simply because it is not a high dividend, and we thought we might, with perfect advantage to the Company, maintain the present rate, but in so doing we had to draw to a small extent upon our reserve fund. I think it was fortunate that we did so.

Mr. John Hollocombe (a Director): We did not draw upon the reserve, but upon the amount carried forward.

Mr. Pender: Well, upon the amount kept in reserve against payment due by the Uruguay Government. We have since received a portion of the debt due from the Uruguay Government, which justifies this step being taken. We received on the 5th of May a telegram from our agent, Senhor Lanza, saying: "We have collected from the Government 9,262 dollars in treasury bonds, corresponding to last year's account; also, 1,853 dollars of consolidated bonds, balance of the years 1879 and 1880." This means, according to our computation from written advices, that the Government have given bonds for their indebtedness subsequent to 1879 of £2,400 nominally; or between £1,100 and £1,200 actual value—but this fluctuates—leaving an unpaid debt of £7,000 to be adjusted. As to this we have made anxious inquiries, and hope by keeping steadily at the government, we shall have our reward by getting sums paid in the same fashion as has been done during the past year. When the payment in bonds was made, we telegraphed to our agent, asking whether it would be judicious to sell the bonds, and, as to their realisation; we have not yet received his answer. I must say that, in relation to our agents there, their zeal has been very great, and I think the terms on which they stand with the Government has enabled them probably to be fairly successful in what they have obtained. We all know such governments are generally impecunious; it is very difficult for them to show a margin over the expenses of maintaining ordinary service of the Government. I think we are justified in thinking we shall, by degrees, get our money. This company's revenue is derived from two sources, both of which are set out in the accounts. Our share of the cable messages for 1882 was £15,700, against £15,622 in 1881, and £18,590 in 1880. This falling off is attributable to the competition of the Brazilian Government land lines with the cable system of the Western and Brazilian Company, from which system this company mainly derives its revenue. This we have qualified as inequitable. I think it is a very unjust and unfair thing on the part of the Brazilian Government, after having invited this submarine connection, to almost break their promise that nothing should be allowed to interfere between the submarine connection and the Brazilian. The Government have, for some reason of their own, laid down the land line to compete with this section of the submarine system. I am told this section does not pay. It is worked by a department of the Brazilian Company. That company have taken steps, and are keeping pressure upon the Brazilian Government to remove this unfair and inequitable practice on their part. I am hopeful that they will be open to reason, and to see that the system which they are pursuing with regard to the Western and Brazilian will not gain for them either the confidence or the money they require in the future, which they will require if they come into the market. I am anxious that the Government may see these views; and that they may not take them in any unkind spirit, but in the spirit that they may see that in the long run honesty is the best policy. Our land lines and receipts show a trifling increase—£8,645 against £8,335. We have charged the salary of our Rio agent against this account. We have already made economies in our outgoings at Buenos Ayres. I do not see, until this question is settled with the Brazilian Government, any immediate prospect of enlarged dividends. Therefore we have to effect economies where it is possible to effect them. It is our intention to reduce the expenses of our agents abroad; and as it is the right thing that we ourselves should set the example of economy, we have taken a step in that direction. Therefore, though looking at the fees which other directors receive from their companies, probably less prosperous than we are, we think, at all events for the present, we shall credit the reserve fund with a further £200 out of the amounts allowed to the Directors; and we hope when better days come, and dividends are raised, that those who are in office will be entitled to claim the portion of dividend hitherto allotted to the Directors. We feel that we could not well ask our agents to reduce their salaries, without showing that we are prepared to reduce our own. One point remains to be mentioned. Our debentures are falling due in March, 1884. They are now at 7 per cent., and I have no doubt, from the dividend we pay, there will be no difficulty in renewing them at a fair reduction. The Chairman then proposed the adoption of the report and accounts be received and adopted, and that a dividend of 3s. per share, free of income-tax, be declared payable that day.

Mr. John Hollocombe, one of the Directors, seconded the proposition.

Mr. Griffith asked a question concerning 800 shares issued and held by the Company as a guarantee for contract with Messrs. Lemas & Co., dated July 24th, 1872. He had not long been a member of the Company, and would like to know what it meant. It was satisfactory to hear that matter brought forward so frankly. He was also glad the Uruguay Government were seeing the wisdom of being honest, and it was to be hoped the Brazilian Government would see fit to do the same. He believed the Foreign Office were willing to use its private influence in complications or unpleasantness like that existing between this Company and the Brazilian Government; and he would suggest that they might ask Lord Derby to assist them privately by bringing suitable pressure upon those representatives abroad.

The Chairman said he believed the question to which Mr. Griffith referred was still in the lawyer's hands, and he would ask their solicitor to make such a statement as he considered prudent to make under the circumstances. As to the other part of Mr. Griffith's remarks, as to bringing pressure upon the Brazilian Government, the Brazilian Company had many influential men, and he had no doubt they had been acting for some time past upon what Mr. Griffith had suggested.

The Solicitor briefly explained that the matter referred to by Mr. Griffith had no connection with this company, but with the old Brazilian Company, out of which this was formed, and concerned entirely the period of the reconstruction of the company.

A Shareholder said that at the last meeting the chairman informed them that the cost of their land lines was £90,000; the gross revenue for the past three years ending December last had been £25,417, or an average of about £8,472. The net revenue coming to the company, including the amount due to the Uruguay Government was about £2,500. They were not making provision for any large repairs of these lines. According to the money they were expending the duration of these lines must be 460 years. He found the duration of the land lines roughly taken to be between 20 and 50 years, or an average of 35. Of course, if they got only under 3 per cent. as a net revenue, and the land lines were not to last more than 35 or 50 years, they were not justified in dividing this money. He would therefore like to

know if anything could be done to improve the land lines, either by judicious extension, or if they could not improve them in these ways, whether they could not sell them and use some of the money in paying off the debentures due next March? As these debentures returned, would it not be well to see what they could get money at for renewing them? If they commenced early they might be able to dictate terms. If they left it to a late stage they might be obliged to give just what was asked. If they could sell their land lines and pay off that money, they would considerably improve the position of this company.

The Chairman said he had previously explained the position of the company. When they took up that company they found the whole thing had been constructed in a way very different from what the thing would be done to-day. When they spoke about the value of these land lines, as compared with what lines could be put up for, it was a very different thing. They were pursuing somewhat the same course as the Post Office was pursuing under these circumstances; they were expending out of the revenue such an amount as would maintain them in as good a position as if they had only now been put down, so that the laying of the lines was altogether a myth. They maintained them out of the revenue. They took a little credit to themselves for rescuing that property from utter and complete ruin. It seemed more than once as though there were not a shilling in it. True, they were not paying a large dividend; but he thought the best thing they could do was to make the best of a bad bargain. He thought, too, there was a chance of settling the Brazilian question, and if this was settled they could see their way to a fair prospect. In the meantime they were endeavouring to mend their system so as, if need be at any time, to hand it over in a good state. They were willing to sell the Company if they could get such a price as would be satisfactory to their shareholders, but they knew something of the impecuniosity of these governments. Probably if they were to work it so as to get a dividend they might not get paid for it. He simply showed them that they had now, at all events, got a property that was giving them something. The directors were not carrying on the company for any personal advantages, and if they do get such an offer as would place this concern in the hands of a larger and more powerful company that could utilise it, and who could effect greater economies than they could, he would advise the shareholders to consider it. As to the debentures, there was no doubt that the suggestion was one which financial men naturally looked to, but they would take steps at the proper time. This was, perhaps, not the very best time; the money market was not very favourable. They should take steps however, say, about six months before the time, to ask at what price the debenture holders were likely to take them up.

Mr. Kendall inquired if the Directors had power to deal with the debenture question without consulting an ordinary meeting? He would just like to say, with regard to the claim upon the Uruguay Government, that he thought there never was a time when that claim could be pressed with greater prospect of success then at the present. There was a rumour afloat that the Uruguay Government was likely to consolidate and pay off its debts.

The Chairman thought their agents abroad had shown great zeal in endeavouring to get the money; and, if the Government had it, he had no doubt they would get it. They were getting little by little. He thought they were getting now such sums as their friends at one time thought they would not get.

Capt. F. Pavy (a Director) proposed the re-election of Mr. John Pender, M.P., as a Director of the Company, and paid him a high compliment.

This was seconded by Mr. Hollocombe (another Director), and carried unanimously.

The Chairman briefly responded.

Mr. Ford next proposed the re-election of Messrs. Deloitte, Dever, Griffiths & Co., as auditors to the company, at a remuneration of £25 a year.

Mr. Griffith seconded, and the proceedings shortly afterwards concluded, with a vote of thanks to the Chairman, proposed by Mr. Griffith.

The Oriental Telephone Company (Limited).

THE third ordinary annual general meeting of this company was held at the Cannon Street Hotel on Wednesday, Colonel Gouraud presiding.

The Secretary (Mr. W. G. Hall) read the notice convening the meeting, and

The report of the directors was taken as read. It said:—The company has now in operation, or is interested in, exchanges in Alexandria, Cairo, Calcutta, Madras, Bombay, Kurrachee, Rangoon, Colombo, Singapore, Hong Kong, Shanghai, and the Hawaiian Islands. At the date of the last report the number of subscribers, including those in Honolulu, using the company's lines, was 409. There are now 1,098 subscribers to exchanges and private lines, so that during the year the total increase has thus been in exchange and private lines 689 subscribers, an improvement of upwards of 160 per cent. After setting aside, under article 80 of the Articles of Association, the sum of £7,000, which may hereafter be applied to meet possible claims under guarantees, there remains a net profit of £6,358 14s. 8d. for the year, in addition to the amount standing to the credit of the suspense profit account, representing this company's interest, of 13,680 shares of Rs. 25 each in the Bombay Telephone Company (Limited), equal, at 1s. 8d. per rupee exchange, to £28,500. An interim dividend of 2½ per cent. has already been distributed, and the directors recommend a further dividend of 2½ per cent., making a total distribution on the ordinary shares of 5 per cent., free of income-tax, for the year. After providing for this dividend there will remain an amount of £709 4s. 8d. to be carried over to the credit of profit and loss account for the current year, in addition to the suspense profit account above referred to, which will hereafter be dealt with.

The Chairman said he was sure they would all be sorry to learn that the Chairman of the Company, Mr. John Pender, M.P., was unable to be present through death in his family, not in his immediate family, he was happy to say, but still he could not attend as the funeral was fixed for that day. Before moving the adoption of the report, he would call two or three matters to their notice. While that was stated as being the third ordinary general meeting of the company, he thought the report and accounts might with great appropriateness be said to be a statement of the first year's business of the company. The operations of the company as they knew extended over a very wide sphere, including many countries widely separated from each other, and all at a great distance from home. The early operations of the company were very much embarrassed by many things, but of these he should only mention two or three. They took over from the vendors a going business in certain places, and with it the agents whom they sent out. Almost without exception these agents had to be replaced, and a very large amount of the work they did had to be replaced, not representing a great deal of money, but a considerable loss of time. At the last meeting the chairman was able to tell them that the business of the company in several places was fairly under way, and stated that there were then 409 subscribers. Considering they had at that time hardly begun that was a fair number. The number up to the 31st December last was 1,098, an increase of 160 per cent., and since that date the increase had gone on steadily almost everywhere, and was now between 1,100 and 1,200. He thought that was a satisfactory increase. It would have been very much greater, no doubt, but for certain obstacles which were almost universally experienced in that kind of business, namely, the difficulties in the running of their wires—the objections some owners of properties had to their fixing their wires to the roofs of their buildings. In India they were not allowed to run their wires on roofs, but were compelled to erect poles, and the authorities there were fastidious not only about the construction but about the appearance of the poles, which involved them in considerable outlay; but the poles had their advantages in the long run, as by them they were able to connect additional subscribers with much greater rapidity. In other places they had not been allowed to run their wires on poles when they would have liked to and had to do it on the housetops. As the business went on, however, they might hope for a more rapid increase in the facilities for connecting subscribers and consequently an increase in the number of subscribers. Reference was made in the report to the setting aside of £7,000. That was a matter of precaution. On the subject of interim dividend he should explain that to it some objection had been made by one shareholder and another. The smallness of the dividend arose chiefly out of the fact that the denomination shares were simply £1 and the amount paid on the shares 10s.; consequently if a shareholder held few shares, his dividend was very small. If the directors had consulted their own convenience entirely, he did not think they should have declared that dividend. In the earlier days of the company the chairman, he remembered, indicated that the policy followed by the board was one which would lead to the formation of companies in the different countries in which they were operating. Since then a company had been formed for Egypt. In that country the progress of the business had been remarkably satisfactory and continued to be so. The business at Alexandria, where it had been first established and first demolished by the late war, had been re-established, and its growth had been proportionately more rapid than before. Their service in Egypt generally had been so satisfactory, and its results so appreciated by the people and the Government, that they recently extended their concession, which originally was limited to Cairo and Alexandria, to Port Said, Ismailia, Suez, Zagazig, Mansourah, and Tantah. In these places a profitable business could be done, and they hoped to connect all of them the one with the other. In Bombay the agreement had been completed with regard to the sale of the company's interest there. They had received money due to them; they had received the shares, and the money was now in the hands of the local board. There the development of the telephone had not quite equalled his expectations. It might go on more rapidly later on. They had not yet succeeded in tapping the native community; when they did that they might look for a very large increase in their present business. In Alexandria the native element had already begun to come in, and that was regarded as very significant. In Calcutta a local company had been formed and the business was gradually increasing. There, as in Bombay, they had not yet secured many native subscribers. In Burmah the business was steadily increasing, though recent troubles in the rice trade had retarded its progress; in Madras business was improving, and in Colombo the tendency was towards an improvement, though the number of subscribers was small. They started there with too high a rate, and his opinion was that that had been the case in many places. In the Straits Settlements the Singapore Exchange was a steady dividend-yielding concern, and they were looking for a very material increase in the business during the year. The business in China was disappointing. They were met with a competing firm, which violated their rights, but they had brought it to a reasonable view of the situation, and they had made a compromise which was entirely satisfactory. Another difficulty which they had met with there was an entirely original one, differing from anything they had experienced anywhere else. The Chinese were a good deal mystified by the extraordinary performances of the telephone, and noticed that in certain conditions of the wind the overhead wires caused a certain musical sound. They thought this sound was caused by the influence of an evil spirit, which was greatly to the company's disadvantage. He believed, however, that they were now changing their minds as to the influence of this mysterious spirit, and the subscriptions were increasing. In the Hawaiian Islands the business was steadily increasing. Until recently they delayed doing anything in the Mauritius. They had now decided to open an exchange in Port Louis, and an electrician and material had already been despatched there. The most significant remark he could make,

he thought, of a general character, would be to tell them that the net receipts at the present time, from what he called the really established business—without looking to anything from the sale of rights to companies, or the cash they might receive from such sales—gave promise of a reasonable dividend, unless upon their share capital, which was small compared with the business they were doing and the extent of their operations. In the accounts in the London expenses there were several items which struck him as perhaps large. Amongst them he would mention stationery and printing, and advertising. He was satisfied they were larger than they would be this year. With regard to the principal item, directors' remuneration, he would call their attention to the fact that while under the articles they were entitled to receive £2,500, they had arbitrarily among themselves agreed for the past year to take only £1,500. It was a pretty large board, and he thought it was very moderate compensation considering the amount of work done. Their interest in the Hawaiian Islands was in shares in the local company. They had anticipated some little difficulty in that quarter so they appointed an agent with a member of the legal profession to look after their interests. A question arose as to the legality of their holding shares in that company, and having taken it to the law courts they had won their case. Nothing further occurred to him to volunteer to them in the way of remarks. They were honoured to-day by the presence for the first time of the most distinguished member of his profession, Sir William Thomson. (Applause.) He should like to make one remark on the subject of the telephone industry. He presumed he was not exaggerating when he said there was no parallel to the growth of the telephone industry as an industry throughout the world. The American development had been extraordinary. The exchange subscribers in that country numbered 100,000. During last year they increased by 27,000. There were no less than 30,000 miles of telephone wires in America. The value of telephone property in the United States alone was estimated, at the market value of shares, at over 100 millions dollars or two million pounds sterling.

In answering a question put by a Shareholder,

The Chairman said it was his deliberate opinion that, regardless of the past or present market price of the shares there had been no time when the shares of the company were intrinsically worth anything like as much as they were that day.

Mr. St. John Ackers asked, in regard to the Alexandria indemnity, whether or not theirs was a claim which had already been acknowledged.

The Chairman replied that their claim had been so far acknowledged that an appraisement of their losses had been gone into.

Mr. St. John Ackers also called attention to the London expenses, and asked if they could not be materially reduced. While they gave the London expenses in the account they gave no idea, he noticed, of the expenses abroad. In regard to the directors' remuneration, he hoped the directors would be moderate in that respect until the company was more advanced (applause).

The Chairman said, with reference to the London expenses, that they were already having the board's careful attention and revision. He did not believe, however, that there was great room for reduction. He himself would be dissatisfied in taking less remuneration than he was getting. They were paying no unreasonable commissions, he assured them, neither to gentlemen abroad nor at home.

Mr. A. F. Dewing could not look upon the company as in the flourishing condition represented by the chairman.

The Chairman moved the adoption of the report and accounts, and the declaration of a dividend on the ordinary shares of 2½ per cent.

Sir William Thomson seconded, and congratulated the company on the progress it had already made. The work undertaken was, as they all knew, of very widespread ramifications, with centres of action over a very large area of the globe. The amount of work involved in making the necessary arrangements to spread the operations of the company so far and wide was something very serious. Although the profits hitherto made were not so large as they would all desire, he thought the business seemed to be in a very healthy condition, and might be looked forward to to increase in a highly satisfactory manner. (Applause.)

The motion was unanimously adopted.

The retiring auditors, Messrs. Deloitte, Dever, Griffiths & Co., were re-elected.

A vote of thanks to the chairman concluded the meeting.

The Faure Electric Accumulator Company (Limited).

A MEETING of the shareholders of this company was held at the Cannon Street Hotel, on Tuesday, in accordance with a circular signed by Mr. Harcourt Turner, which said:—"Our present position appears to be this: We are a company with the chairman of our board of directors under arrest and our remaining directors apparently afraid or unwilling to meet the shareholders. Can we, under these circumstances, hope for success? I cannot myself think that any respectable body of private individuals will for one moment entertain the idea of transacting business with such a company. What, then, is to become of us?" With the view, if possible, of determining that question Mr. Turner called them together. Mr. Harcourt Turner presided and there was a fair attendance.

The Chairman thanked the shareholders for answering his circular. He felt the affairs of the company were such that it was absolutely necessary an investigation into them should be made. Before he went further he should read a letter he had received on the previous evening from the secretary of the company, containing an amicable precaution to them. It was dated the 28th May, and was as follows:—

"Sir,—With reference to your circular convening a meeting of the shareholders of this company for to-morrow, the 29th inst., I am instructed by my directors to inform you that they would amicably caution you, so that you may avoid acting in any manner which might be perverted by the enemies of M. Philippart. A *mémoire*, written by M. Philippart, a translation of which is now being prepared for issue to the shareholders, shows that M. Philippart has been the victim of treacherous attempts to overthrow him and to seize upon the results of his labours, and my directors feel sure you will recognise that it should be the policy of the shareholders of this company to refrain from in any way aiding these attempts, and any injudicious action on your part might very injuriously affect the position and prospects of this and the French company by tending to seriously prejudice M. Philippart's position. It was hoped that the shareholders would have been in possession of the *mémoire* prior to your meeting, but the original came to hand only last week, and it has been found impossible to translate, print, and issue it in time. My directors have to request that you will kindly read this letter to your meeting, or, should you not take the chair, kindly ask the chairman thereof to do so. I am, yours obediently,

"HERBERT CANNING (Secretary)."

The very first thing the new directors did, the Chairman continued, was to make a call of £1 a share, and also to declare a dividend of 3s. a share. In looking into the articles he found the directors had ample powers to determine what was capital and what was income, and he then thought it no good taking further steps in the matter. Affairs went on until the arrest of Philippart, when he wrote to the secretary and reminded him that he had told him that the general meeting was to be held in March or April, and that if it was not held by the end of April he should take such steps to bring the affairs of the company before the shareholders. To that letter he received a reply that the board had fixed the 10th or the 17th of May to hold its meeting. Both the 10th and the 17th had gone by, and it was quite clear that unless the directors had a screw put upon them they would not do anything for them; hence that meeting. At the beginning of the year Philippart was the owner of 20,000 odd shares, but the register he had got for April 11th said his number of shares was reduced to 50. It seemed to him strange, after Philippart telling them the wonderful things the company was to do, that he should now come to have only 50 shares, which was necessary for him to hold to have a seat on the board. The state of affairs being such, what could they hope to do in the way of business? Their chairman was under arrest, and from what he could hear he was likely to be in durance for some time; and did they expect that any respectable set of people would do business with them under those circumstances? He had asked them to meet him there that day to consider the best course they ought to adopt, and he should be happy to hear any suggestions anybody had to make.

In reply to a question by a Shareholder,

The Chairman said he had heard nothing from the former directors.

Mr. Montague Turner was of opinion that M. Philippart was not such a man as they should have for their chairman, and they therefore should not confide their trust in him any longer; the time had come when they should withdraw it. He suggested that a committee should be appointed.

It was then agreed, on the motion of Mr. L. A. Solomon, seconded by Mr. W. D'Oyley, "That a committee of investigation be appointed from among the shareholders present to examine into the present position of the company and to report thereon to the shareholders, with a view to decide what action should be taken thereon, but that no active steps be taken by the said committee until after the 26th prox., the day appointed by the directors for their annual meeting."

The following gentlemen were then appointed the committee:—Mr. Ponsonby, Mr. H. Turner, Mr. Solomon, Sir Charles Clifford, and Mr. D'Oyley.

A vote of thanks to the chairman closed the meeting.

Submarine Cables Trust.

THE 12th ordinary annual meeting of the certificate holders of the Submarine Cables Trust was held on Tuesday afternoon last at the offices of the Trust, 66, Old Broad Street, Mr. John Pender, M.P., presiding.

The secretary having read the notice convening the meeting, and the report having been taken as read,

The Chairman said: Gentlemen, there is very little left for me to say except that our investments are in an uncommonly good and improved position, particularly the Eastern and the Eastern Extension Company. Their dividend has been increased, and the increase of these dividends of course places our securities in a better position. Last year our returns from the Anglo-American, in which we have a large investment for our securities, were less, and consequently gave us less money to invest in the purchase of our certificates. Therefore we consider they are now at a fair price, although, compared with the real value of the stocks they are, probably, something like £10 below their real intrinsic value. However, that value is more or less fluctuable. As opportunity occurs, as we have money, we go on purchasing our certificates; but at the present moment we have very little in hand for that purpose. I beg to move the adoption of the report and accounts.

The Marquis of Tweeddale seconded the motion, which was carried unanimously.

The retiring auditors, Mr. John G. Griffiths and Mr. John Gane, were re-elected on the motion of Mr. Ashton, seconded by Mr. Cashman.

A Shareholder asked if they were likely to be free from competition in the future.

The Chairman said that he could only give them his individual impression, and that was that after the storm they generally had a calm. At one time there had been a talk of a combination being formed between Mr. Garrett, of Baltimore, and Mr. Bennett, but he

believed it was only talk, they had now eight cables in the Atlantic, which were capable, since they could now be duplexed, of carrying about three times the amount of work that they at present had. He could not say what they might have to do ten years hence. It would require a bold man to attack the system allied with theirs which was directed by, perhaps, the most able and enterprising men whom America had in these times produced. He always had thought that telegraphs ought to be a grand investment. The Eastern Extension was doing well and likely to do better, the public were beginning to see all that and to go into telegraph property as a permanent investment. He anticipated that before long there would be a demand for their stocks.

On the motion of Mr. Keenliside, seconded by Mr. T. H. Wells, a vote of thanks was awarded to the chairman and directors and the meeting separated.

The Great Western Electric Light and Power Company (Limited and Reduced).—The secretary of this company intimates that the following gentlemen have been elected directors in the place of the old directors, who have resigned:—Mr. J. B. Braithwaite, jun., Mr. C. H. Stewart, Mr. F. W. Reynolds, and Mr. Charles Bell.

Call.—A call of £2 is due on the 30th inst. on the Eastern Extension Australasia and China Telegraph Company's £10 shares issued at £1 premium, £8 having already been paid.

LATEST QUOTATIONS.

Authorised Issue.	Share.	Name.	Paid	Closing Quotations. May 30.	Business Done.
		ELECTRIC LIGHT.			
40,000	10	Anglo-American Brush Co.	7	4⅛ - 4¼	4⅛, ⅞, 4⅛, 4¼
		Do. Do.	10	7 - 8	7⅛ 15/16
30,000	5	Australasian Electric Light, Power & Storage Co.	3	⅛ - ¼	
24,900	10	British Insulite Co., Limited, "A" Shares	5	1⅛ - 2⅛	
30,000	5	Brush Electric Light & Power Co. (Scotland)	2½	⅜ - ½	
25,000	5	Great Western Electric Light & Power Co.	2½	⅜ - ½	
24,980	5	Hammond Electric Light & Power Supply Co.	2½	2¼ - 3	
40,000	5	Indian & Oriental Electrical Storage Works Co.	2	.. - ..	
172,500	1	Maxim-Weston Electric Light and Power Co.	1	⅛ - ¼	
..	..	Metropolitan Brush Electric Light & Power Co.	3	.. - ..	
40,000	5	Pilsen-Joel & General Electric Light Co.	2	⅛ - ¼	
..	..	South African Brush Electric Light & Power Co.	2½	.. - ..	
100,000	5	Swan United Electric Light Co., Limited	2½	1⅜ - 1½	
		TELEGRAPHS.			
2,116,400£	Stk.	Anglo-American, Limited	100	50 - 51	50⅛
2,441,800	Stk.	Do. Preferred (Def'd. receiving no div. until 6 p. c. has been paid to Pref.)	100	82 - 83	
2,441,800£	Stk.	Do. Deferred	100	19½ - 20½	
130,000	10	Brazilian Submarine, Limited	10	11⅝ - 12	11⅝
16,000	10	Cuba, Limited	10	10 - 10½	
6,000	10	Do. 10 per cent. Preference	10	17 - 18	
13,000	10	Direct Spanish, Limited	9	5½ - 6	
6,000	10	Do. 10 per cent. Preference	10	16 - 16½	16
65,000	20	Direct United States Cable, Limited, 1877	20	12⅜ - 12⅝	
100,000£	100	Do. 6 per cent. Debenture, repayable 1884	100	99 -102	
380,000	10	Eastern, Limited	10	10⅜ - 10⅝	
70,000	10	Do. 6 per cent. Preference	10	13 - 13½	
232,000£	100	Do. 6 do. Debentures, repayable Oct. 1883	100	99 -102	
200,000£	100	Do. 5 do. do. Aug. 1887	100	101 -104	100⅜
200,000£	100	Do. 5 do. do. Aug. 1899	100	104 -107	
199,750	10	Eastern Extension, Australasia & China, Limited	10	12 - 12½	12⅜
50,250		Do. New Shares, 1883	8	8¾ - 9	
320,000	100	Do. 6 p. c. Debentures, repayable Feb. 1891	100	107 -110	
500,000	100	Do. 5 p. c. (Australian Gov. Subsidy) Deb. 1900	100	104 -107	
140,000	100	Do. do. registered, repayable 1900	100	104 -107	
100,000£	100	Do. 5 per cent. Debenture, 1890	100	101 -104	
254,300£	100	Eastern and South African Limited 5 per cent. Mort. Deb. Registered redeemable 1 Jan 1900	100	103 -106	
345,700£	100	Do. do. do. To Bearer	100	103 -106	
22,050	10	German Union Telegraph and Trust Limited	10	9¾ - 10½	10
163,390	10	Globe Telegraph and Trust, Limited	10	7 - 7¼	7⅛
163,209	10	Do. 6 per cent. Preference	10	12¾ - 13	
125,000	10	Great Northern	10	12¾ - 13	
100,000£	100	Do. 5 per cent. Debentures	100	101 -104	
300,000	100	Do. 5 per cent. Debentures	100	101 -104	
31,200	10	India-Rubber, Gutta-Percha and Telegraph Works	10	29½ - 30½	
100,000	100	Do. 6 per cent Debentures, 1886	100	103 -106	
17,000	25	Indo-European, Limited	25	31½ - 32½	
38,148	10	London Platino-Brazilian, Limited	10	3¾ - 4¼	
12,060	10	Mediterranean Extension, Limited	10	1½ - 2	
8,200	10	Do. 8 per cent. Preference	10	6 - 7	
9,000	8	Reuter's, Limited	8	9½ - 10	
280,000	Stk.	Submarine	100	247 -252	
58,225	1	Do. Scrip	1	2 - 2¼	
4,200	Cert.	Submarine Cables Trust	100	107 -111	
37,350	12	Telegraph Construction and Maintenance	12	34 - 35	
150,000	100	Do. 6 per cent. Bonds, 1884	100	101 -103	
186,750	5	Do. 2nd Bonus Trust Cert.	2½	1⅜ - 1¼	
30,000	10	West Coast of America, Limited	10	4½ - 5	4⅝
150,000	100	Do. 8 per cent. Debentures	100	107 -109	
69,910	20	Western and Brazilian, Limited	15	6½ - 6⅝	6⅝
200,000£	100	Do. 6 per cent. Debentures "A" 1910	100	105 -110	
2,500	100	Do. 6 p.c. Mort. Deb. series B of '80, red. Feb., 1910	100	100 -103	
1,500	$1,000	Western Union of U. S. 7 p.c. 1 Mort. (Building) Bds.	$1,000	122 -124	
1,030,000£	100	Do. 6 per cent. Sterling Bonds	100	103 -105	
88,321	10	West India and Panama, Limited	10	1¼ - 1⅜	
34,563	10	Do. 6 per cent. 1st Preference	10	6¾ - 7	7
4,669	10	Do. 6 do. 2nd do.	10	5 - 5½	
		TELEPHONES.			
154,165	1	Con. Telephone & Maintenance, Ld. Nos. to 154,165	1	⅛ - ¼	
200,000	1	Oriental Telephone Co., Nos. 80 001 to 300,000	¼	⅜ - ½	¼
100,000	5	United Telephone Co.	5	9¼ - 9½	9¼

NEW PATENTS—1883.

2473. "Insulating electrical conductors." A. J. BOULT. (Communicated by J. G. Sanderson.) Dated May 17.

2482. "An improved electromotive-engine." A. BROWNE. Dated May 17.

2489. "Electric current meters." W. MURRAY and H. M. CAPNER. Dated May 18.

2493. "Apparatus for measuring electricity." J. D. F. ANDREWS. Dated May 18.

2499. "An improved insulation and mechanical protection for electrical wires." W. A. PHILLIPS. Dated May 18.

2528. "Holders for incandescent electric lamps." A. SWAN. Dated May 21.

2539. "Arc regulator lamps." R. E. B. CROMPTON and T. CRABB. Dated May 22.

2543. "Use of incandescent electric lamps for artistic illumination." B. KEELING and J. D. MUCKLOW. Dated May 22.

2550. "Microphones or telephones." P. JENSEN. (Communicated by L. M. Ericsson.) Dated May 22.

2553. "Dynamo-electric machines and electro-motors." T. T. VERNON. Dated May 22.

2563. "Opening doors by means of electricity and apparatus therefor." G. F. REDFERN. (Communicated by A. Gautier.) Dated May 22.

2570. "Electric arc lamps." P. JOLIN and J. PARSONS. Dated May 23.

2573. "Manufacture of porous or spongy plates, particularly applicable for use in secondary batteries or accumulators, and also for other purposes." F. T. WILLIAMS and J. C. HOWELL. Dated May 23.

2575. "Apparatus to electrically indicate the movements or passage of trains on railways." E. C. WARBURTON and R. R. HARPER. Dated May 23.

2579. "Means and apparatus for electric lighting on railway trains and other vehicles, also partly applicable for the production and distribution of electric currents generally." W. STROUDLEY and E. J. HOUGHTON. Dated May 23.

2592. "Telephonic apparatus, intended more particularly for domestic use." G. E. GOURAUD. Dated May 24.

2651. "Laying electrical conductors in the ground, and an insulating compound to be used for electrical purposes generally." H. J. ALLISON. (Communicated by J. Greives and J. H. Bleoo.) Dated May 29. (*Complete.*)

2661. "Electric arc lamps." J. BROCKIE. Dated May 29.

2667. "Telephonic transmitting apparatus." J. GRAHAM. Dated May 29.

2670. "Dynamo-electric machines." W. HOCHHAUSEN. Dated May 29.

2673. "Galvanic batteries." A. M. CLARK. (Communicated by G. G. L. Velloni.) Dated May 29.

2675. "Improvements in electrical meters, which improvements are also partly applicable to motors to be employed for other purposes." T. J. HANDFORD. (Communicated by T. A. Edison.) Dated May 30.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1882.

4547. "Dynamo-electric machines." R. BARKER. Dated September 23. 4d. The object of this patent is to produce a dynamo-electric machine of simple construction for electro-metallurgy, electric lighting and other purposes. Fig. 1 represents an elevation of dynamo, showing five of the field magnets. Fig. 2 represents the end view of the dynamo, showing outside view of front disc, with aperture for removing armature; also five of the field-magnets

FIG. 1.

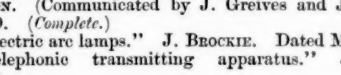


FIG. 2.

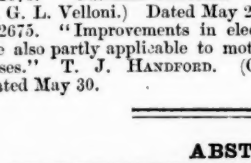
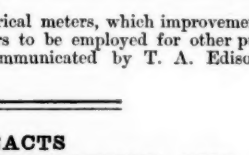


FIG. 3.



secured to the outside circumference of the disc. Fig. 3 shows the inside view of the opposite disc with field-magnets showing serrated edges.

4596. "Apparatus for measuring and regulating electric currents." S. Z. DE FERRANTI and A. THOMPSON. Dated September 27. 6d. Has for its object improvements in apparatus for measuring and regulating electric currents. For measuring the quantity of an alternating current passing through an electric conductor the current is passed through the primary wire of an induction coil. The terminals of the secondary coil are connected to two electrodes immersed in water slightly acidulated. The secondary induced current is directly proportional to the primary current, and the gas generated by the decomposition of water by the two electrodes is proportional to the current passing through the secondary coil. The amount of gas generated can be measured in any suitable apparatus such as now used for measuring gas, but preferably the inventors employ for this purpose a small gas measuring chamber which is open at the bottom, and at the top is carried by a central horizontal axis on which it can rock. The horizontal axis is placed vertically above the electrodes, and a partition is carried downwards from it to divide the measuring chamber into two compartments. An arm also extends vertically upwards above the axis, its weight causes it to incline over to one side or the other, and so to incline the measuring chamber. The extent to which it can so incline is controlled by fixed stops against which the arm strikes. When the measuring chamber is inclined in one or other position both electrodes are below the lower compartment, and the gas rising up from them collects in this compartment When sufficient gas has collected in the compartment to cause it to rise the chamber rocks on its axis until the compartment comes into a position in which it empties itself of gas whilst at the same time the other compartment comes into position above the electrodes—this latter compartment now in turn gets filled with gas, and so the operation goes on continuously. The rocking chamber by a pawl is made to give a step by step revolving motion to a ratchet wheel on the first spindle of a recording train of wheels, and so the number of oscillations of the measuring chamber are recorded.

4599. "Secondary or storage batteries, &c." W. CLARK. (Communicated from abroad by Nicolas de Kabath, of Paris.) Dated September 27. 2d. This invention relates to improvements in the construction of storage batteries or gas batteries, polarised or secondary batteries for the storage of electricity, and consists principally in the method of producing spongy lead. (*Provisional only.*)

4625. "Secondary batteries, &c." ST. GEORGE LANE-FOX. Dated September 28. 6d. Has reference to Planté's secondary batteries, and consists of an improved construction and arrangement of the lead plates so as to give an increased storage capacity. The inventor takes a number of strips of lead plate or foil and places layers of sand, asbestos, paper, or other suitable porous material between them, and then presses them together so as to form a thick plate, which will thus be composed of laminæ of sheet lead and a porous isolating substance. He connects together all the strips forming this plate at the top or bottom or both by lead. He mounts two or more of these laminated plates in a vessel of glass or other suitable material containing dilute sulphuric acid in such manner that the edges of the strips composing the laminæ of one plate or set of plates which form one pole of the cell are opposed to, but do not touch, the edges of the laminæ of the plate or plates which form the other pole of the cell. The invention further relates to means whereby any cell or cells of the battery may be cut out when required while charging the battery or otherwise.

4645. "Electric meters." S. D. MOTT. Dated September 29 6d. This invention consists of certain arrangements whereby the quantity of electricity passing through a conductor at any time is indicated by an index pointer passing over a graduated scale, which index pointer moves forward or backward from or towards the zero point of the scale according to whether the quantity of electricity passing through the conductor is greater or less. The index pointer may also be made to register its movements on a travelling sheet of paper by means of a pencil or style whereby not only the quantity passing at any given time, but the total quantity passed during any given time is indicated graphically. According to one arrangement, the index pointer is moved by the extension or contraction of a metallic spiral caused by the change of temperature produced therein by the passage of a greater or lesser quantity of electricity through the same. The said spiral is composed of a metal which offers considerable resistance to the passage of the current, such as platinum or iridio-platinum, for example. It may be combined with another more elastic metal, or with a spring for the purpose of returning the spiral and the index to the normal position with greater certainty when the current ceases to pass.

4646. "Electric meters." S. D. MOTT. Dated September 29. 10d. This invention consists of certain arrangements whereby the speed of a train of wheels constituting a counting or registering apparatus set in motion by a weight, a spring, electric or other suitable means is caused to vary according to the quantity of electricity passing through the conductor, so as to register the number of units or "Webers" of electricity so passed.

4661. "Apparatus for registering the supply of electricity." J. H. GREENHILL. September 30. 2d. The inventor uses, by preference, clock-work to impart regular motion to a cylinder, disc, or frame carrying a sheet or sheets, or roll of paper, which, for convenience of calculations, may be ruled into spaces representing divisions of time and strength, or quantity of the electric current. A light lever which is furnished with a pen, pencil, or other medium for marking the paper, is connected to the armature of a solenoid or other electro-magnet, or the armature may be fixed and the electro-magnet attached to the lever, so that when the main current of electricity or portion thereof passes along the wire of the electro-magnet, the lever will be moved accordingly, and mark the paper in a somewhat similar manner to the record of a barometric or other indicating intrument of a like purpose. (*Provisional only.*)

4665. "Electro-motor." M. IMMISCH. Dated September 30. 6d. Relates to an improvement in that class of electro-motors in which the number of armature magnets is so proportioned to the number of field-magnet poles that each armature magnet should at any given moment occupy a different place in the magnetic field as compared with the rest of the armature coils, the object being to obtain an equal pull and uniform action. Fig. 1 is a plan view of

FIG. 1.

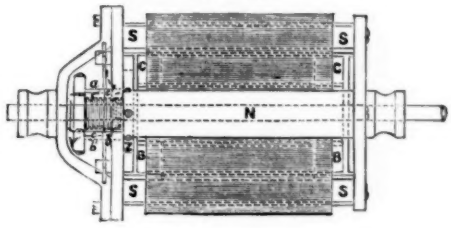
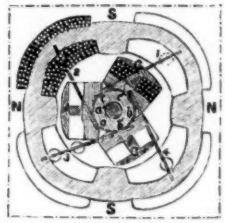
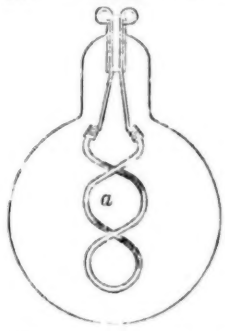


FIG. 2.



one form of the improved motor, and fig. 2 is a transverse section of the same taken partly through the field-magnets and the armature magnets and partly through the commutator. In fig. 2 only one of the coils of the field-magnets, and one of the coils of the armature-magnets are shown in section, but it will be understood that all the field-magnets and also the armature-magnets are similarly provided with coils. A, B, C are the cores of the armature-magnets; 1, 2, 3, 4 are the brushes or contact springs, 1 and 3 forming one pair and 2 and 4 the other pair. These brushes are in frictional contact with the commutator, consisting of twelve segments, six of which are visible in fig. 2, viz., a and a^1; b and b^1; and c and c^1. These segments are connected to the ends of the wires of the armature coils, the outer ends of the coils being connected to the segments a^1, b^1, and c^1, and the inner ends to the segments a, b, and c, These six segments are each and singly in metallic connection with one of another series of six segments.

4676. "Incandescent electric lamps, &c." J. F. PHILLIPS. (Communicated from abroad by C. H. F. Müller, of Hamburg.) Dated October 2. 6d. This invention relates to improvements in electric lamps, where the light is produced by the incandescence of carbon in a vacuum, and the objects of the improvements are:—First, that around the axis of the lamp or bulb an equal lighting surface will be visible; second, to impregnate the material (used for the carbon filament) thoroughly before or after or before and after the carbonisation with liquids which will increase or render the material homogeneous; and, third, the employment of a material specially suitable for such carbons. The carbon filaments of incandescent lamps, when observed from certain points of view, only allow a single line to be visible, because the ascending part of the bow obscures the descending one,



and *vice versâ*. The diffusion of the light at such points of view is consequently proportionately smaller than at such points where the complete bow can be seen. The carbons are shaped in such a manner as to form two cylindrical or conical spirals crossing one another (as shown in the figure), and may be jointed at the one end, or it may be complete, and the free ends connected to the conducting wires in any convenient manner. A suitable material for such carbon filaments are strips of sugar-cane, which are impregnated before the carbonisation with a solution of hydrate of carbon in water, so as to make them more flexible. After being shaped and carbonised, the carbon coils are again impregnated with a solution of cellulose, &c., for

filling all pores of the vegetable fibre. These two impregnations are executed in the vacuum in such a manner that the carbon coils or filaments are placed in closed receptacles from which the air is extracted, and which are filled before the readmission of air with the convenient solution.

4680. "Electric machines." J. S. BEEMAN, W. TAYLOR, and F. KING. Dated October 2. 2d. The improvements consist of mechanical means for making the field-magnets revolve in an opposite direction to the armature if moving, or in either direction if the armature be stationary, combined with apparatus for adjusting the brushes, together with known modes for the field-magnets, revolving at a velocity equal to that of the armature; also in the modes of construction of the field-magnets and pole-pieces and armature; also in winding field-magnets with insulated metal for the purposes of getting alterations of tension on the same machine; also in commutators for insuring closer contact, and yet avoiding friction; also in the use of iron for covering the field-magnets or armature, or both, in lieu of copper as at present. (*Void by reason of the patentees having neglected to file a specification in pursuance of the conditions of the letters patent.*)

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph Engineers and of Electricians.

AN ordinary general meeting of this society was held on Thursday, May 24th, Mr. Willoughby Smith, president, in the chair. The minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed new members read, the communication entitled "The Cause of Evident Magnetism in Iron, Steel, and other Magnetic Metals," by Prof. D. E. Hughes, was read by the Secretary.

The extreme sensitiveness of the induction balance to all molecular changes in the structure of metals was remarked in my first paper on this subject to the Royal Society;* and in the case of iron and steel it is most remarkable, as the addition or subtraction of $\frac{1}{300000}$ part, or the addition of the smallest iron filing to an already large balanced mass of iron, is at once rendered evident and measureable.

Possessing such an invaluable instrument of research, I was desirous of investigating the molecular construction of iron and steel, but at once I met with a difficulty, viz., that magnetism itself completely changed the character of any piece of iron under investigation; consequently, finding no help or explanation of the effects produced from any accepted theories of magnetism, I was forced to investigate, by means of the induction balance, the whole question of magnetism as existing in the interior of a magnet, and to determine the particular structure for each case, such as neutrality and polarity.

In a recent paper to the Royal Society, upon the theory of magnetism,† I described the use of and demonstrations obtained by the induction balance. In this paper I propose to confine myself to demonstrations that can be repeated without it, and whose effects can be observed by the aid of ordinary magnetic direction needles.

That magnetism is of a molecular nature has long been accepted, for it is evident that, no matter how much we divide a magnet, we still have its two poles in each separate portion, consequently we can easily imagine this division carried so far, that we should at last arrive at the molecule itself possessing its two distinctive poles, consequently all theories of magnetism attempt some explanation of the cause of this molecular polarity, and the reason for apparent neutrality in a mass of iron.

Coulomb and Poisson assume that each molecule is a sphere containing two distinct magnetic fluids, which in the state of neutrality are mixed together, but when polarised are separated from each other at opposite sides; and, in order to explain why these fluids are kept apart as in a permanent magnet, they had to assume, again, that each molecule contained a peculiar coercive force, whose functions were to prevent any change or mixing of these fluids when separated.

There is not one experimental evidence to prove the truth of this assumption; and as regards coercive force, we have direct experimental proof opposing this view, as we know that molecular rigidity or hardness, as in tempered steel, and molecular freedom or softness, as in soft iron, fulfil all the conditions of this assumed coercive force.

Ampère's theory, based upon the analogy of electric currents, supposes elementary currents flowing around each molecule, and that in the neutral state these molecules are arranged hap-hazard in all directions, but that magnetisation consists in arranging them symmetrically.

The objections to Ampère's theory are numerous. 1st. We have no knowledge or experimental proof of any elementary electric currents continually flowing without any expenditure of energy. 2nd. If we admit the assumption of electric currents around each molecule, the molecule itself would then be electro-magnetic, and the question still remains, What is polarity? Have the supposed electric currents separated the two assumed magnetic fluids contained in the molecule, as in Poisson's theory? or are the electric currents themselves magnetic, independent of the iron molecule?

In order to produce the supposed heterogeneous arrangement of neutrality, Ampère's currents would either have to change their position upon the molecule, and have no fixed axis of rotation, or else the molecule, with its currents and polarities, would rotate, and thus be acting in accordance with the theory of De la Rive. 3rd. This theory does not explain why (as in the case of soft iron) polarity should disappear whenever the exciting cause is removed, as in the case of transient magnetisation. It would thus require a coercive force in iron to cause exactly one-half of the molecules to instantly reverse their direction, in order to pass from apparent external polarity to that of neutrality.

The influence of mechanical vibrations and stress upon iron in facilitating or discharging its magnetism, as proved by Matteucci, 1847, in addition to the discovery by Page, 1837, of a molecular movement taking place in iron during its magnetisation, producing audible sounds, and the discovery by Dr. Joule, 1842, of the elongation of iron when magnetised, led De la Rive, in his remarkable "Treatise on Electricity," 1853, to give his theoretical views upon magnetism in the following remarkable words:—

"The whole of the magnetic molecular phenomena that we have been studying lead us to believe that the magnetisation of a body is due to a particular arrangement of its molecules, originally endowed with magnetic virtue, but which in the natural state are so arranged that the magnetism of the body that they constitute is not apparent. Magnetism would therefore consist in disturbing this state of equilibrium, or in giving to the particles an arrangement that makes manifest the property with which they are endowed, and not in developing it in them. The coercitive force should be the resistance of the molecules to change their relative positions."

Wiedermann, in 1861, gives a theory in which he admits the fluids of Poisson, or the elementary currents of Ampère, as the cause of polarity of the molecule, but believes that the molecules are turned in a general direction in the case of polarity, and that in neutrality, like Ampère's, the magnetic axes of the molecules are turned in all directions.

Maxwell, in his remarkable treatise on "Electricity and Magnetism," 1881, page 75, gives the following résumé of Weber's theory:—

"Weber's theory differs from Poisson's, in assuming that the molecules of the iron are always magnets, even before the application of the magnetising force, but that in ordinary iron the magnetic axes of the molecules are turned indifferently in every direction, so that the iron, as a whole, exhibits no magnetic properties." And again, page 429, Maxwell says he agrees with Weber's views, and that neutrality, or unmagnetised iron, has the axes of its molecules placed indifferently in all directions, and that the act of magnetisation consists in turning all the molecules so that their axes are either rendered all parallel to one direction, or at least deflected in that direction.

I have quoted these several theories which admit of the inherent polarity of the molecule, and in that respect they entirely agree with my own; but the induction balance at once shows that they are erroneous in the most important part, for my researches have proved that neutrality is perfectly symmetrical, that there is no case of neutrality where the axes of the molecules are turned indifferently in all directions, and that we cannot obtain perfect neutrality except when the molecules form a complete closed circuit of attraction.

I believe that a true theory of magnetism should admit of complete demonstration, that it should present no anomalies, and that all the known effects should at once be explained by it.

From numerous researches I have gradually formed a theory of magnetism entirely based upon experimental results, and these have led me to the following conclusions:—

1. That each molecule of a piece of iron, steel, or other magnetic metal is a separate and independent magnet, having its two poles and distribution of magnetic polarity exactly the same as its total evident magnetism when noticed upon a steel bar-magnet.

2. That each molecule, or its polarity, can be rotated in either direction upon its axis by torsion, stress, or by physical forces such as magnetism and electricity.

3. That the inherent polarity or magnetism of each molecule is a constant quantity like gravity; that it can neither be augmented nor destroyed.

4. That when we have external neutrality, or no apparent magnetism, the molecules, or their polarities, arrange themselves so as to satisfy their mutual attraction by the shortest path, and thus form a complete closed circuit of attraction.

5. That when magnetism becomes evident, the molecules or their polarities have all rotated symmetrically in a given direction, producing a north pole if rotated in that direction as regards the piece of steel, or a south pole if rotated in the opposite direction. Also, that in evident magnetism, we have still a symmetrical arrangement, but one whose circles of attraction are not completed except through an external armature joining both poles.

6. That we have permanent magnetism when the molecular rigidity, as in tempered steel, retains them in a given direction, and transient magnetism whenever the molecules rotate in comparative freedom, as in soft iron.

Experimental Evidences.

In the above theory the coercive force of Poisson is replaced by molecular rigidity and freedom; and as the effects of mechanical vibrations, torsion, and stress upon the apparent destruction and facilitation of magnetism is well known, I will, before demonstrating the more serious parts of the theory, cite a few experiments to prove that molecular rigidity fulfils all the requirements of an assumed coercive force.

The influence of vibrations, torsion, or stress of any kind upon a magnetised steel or iron rod may be seen by striking with a wooden mallet rods of hard and soft steel, also hard and soft iron previously magnetised to a known degree. The tempered steel, owing to its molecular rigidity, will lose but 5 per cent., the soft steel 60, hard iron 50, and soft Swedish iron 99 per cent. of its magnetism, the amount of loss depending not so much upon whether the metal be steel or iron, as upon its degree of hardness and softness; and as hard steel requires far more power to magnetise it to the same force than iron, it is possible to imagine a

* "On an Induction Current Balance, and Experimental Researches made therewith."—*Proceedings Royal Society*, March 29, p. 56, 1879.

† *Proceedings Royal Society*, May 10, 188

steel so hard that its molecules could not rotate, and that consequently no magnetism could be manifested from a given inducing cause, whilst a perfectly soft iron would give the maximum effect, and instantly return to its previous state. From this we might in error suppose that soft Swedish iron could not retain its magnetism, and that its natural state would be zero, or neutrality. The apparent disappearance of magnetism, however, is here due to the extreme freedom of motion of its molecules allowing them at once to follow the comparatively feeble directing force of the earth's magnetism. We can demonstrate this by feebly magnetising a rod of soft iron held vertically, so that its north pole is at the lower portion. Upon removing the inducing magnet, or electro-magnetic coil, we find that the rod retains a powerful north polarity; but if magnetised in a contrary sense, then we have only *traces* of magnetism left upon the withdrawal of the inducing cause. To succeed in this experiment, as in all others where soft iron is mentioned, we should use the best Swedish charcoal iron, thoroughly annealed at high temperature.

We find, again, that rods of steel or iron will lose far less magnetism when vibrated in the magnetic dip, or vertically, when their north poles are at the lowest extremity, than when horizontal, or still less than when their poles are contrary to those of the earth's field, and also that they will acquire their maximum magnetism from a given exciting cause when held vertically as described, and the molecules allowed greater freedom of motion to obey the directing influence by vibrations, torsion, stress, or blows upon the iron. Any influence that would tend to give greater freedom of motion, such as heat or mechanical trepidations, gives a far higher magnetic force to the iron than could be obtained without these aids.

In order to render visible the effects of motion upon magnetism, we may take two glass tubes, or ordinary phials, of any length or diameter, say 10 centimètres in length by two centimètres in diameter. If we now put iron filings in these tubes, leaving about one-third vacant, so as to allow complete freedom in the filings when shaken, we find that each tube, when magnetised, retains an equal amount of residual magnetism, and that this all disappears upon slightly shaking the tube. We are thus imitating the effects of vibration. But if in one of these tubes we pour melted resin (in fact, any slightly viscous liquid, such as petroleum, suffices), we then render these filings more rigid, and then we can no longer produce by shaking the disappearance of its residual magnetism. In pouring in petroleum we have apparently been introducing a strong coercitive force, but we know that it can only have the mechanical effect of rendering the iron filings less free to turn, and so comparatively rigid. If we desire to see the effect of torsion, we have only to shake the filings so that when the tube is held horizontally the vacant space is above, and rotate it slightly (but without shaking) about a horizontal axis. Its remaining magnetism instantly disappears upon rotation, although we evidently have not changed the longitudinal position of its particles. A similar effect takes place upon a soft iron rod, for if we magnetise it and observe its remaining magnetism we find that, upon giving a slight torsion to this wire, its remaining magnetism instantly disappears—a similar effect to that in the rotating tube of iron filings. But if the iron is rendered more rigid by hammering, or steel rendered hard and rigid by tempering, torsions or vibrations have but little effect, as in the case of the filings rendered rigid as above mentioned. Thus we have no longer need of an assumed mysterious coercive force to account for the retention of magnetism, for once knowing the mechanical qualities of iron and steel, and their degree of molecular rigidity or hardness, we can at once predict their retentive magnetic powers.*

Rotation of Inherent Polarised Molecules.

Torsion, as well as mechanical vibrations, has, as we have seen, a powerful influence in aiding the molecules to overcome their inertia, and thus aid them to rotate in the direction of the inducing influence; and we may thus polarise strongly a flat soft iron rod by simply bending or vibrating it when held vertically, and if we measure the magnetic force obtained we shall notice that the force is strictly relative to the degree of softness of the iron. Thus, with hard steel we should obtain only *traces* of polarisation, whilst with extremely pure soft Swedish iron we obtain the maximum force. The bar of iron or steel, being held in the earth's magnetic field, of infinite size compared with the bar, and infinitely homogeneous, cannot deflect or weaken its surrounding field. Its lower portion being north, apparently strengthens it by its reaction, whilst its upper, south, apparently weakens the field; but, as Maxwell has shown, "the poles of each molecule are equal and opposite, consequently the sum of each molecule and the whole mass must be zero."

We have a far greater induced polarity in iron or steel when the iron is in thin bars or small wires, and this we should expect as the external molecules rotate directly under the influence of the earth's magnetism, whilst those forming the interior of the bar either rotate feebly, or, as in the case of very thick bars, actually act as an armature, preventing, by their influence, free rotation of the exterior molecules.

Thus, as the sum of the two and equal polarities in a bar of iron is zero, it is evident that its polarity must be inherent. I have some remarkably pure soft Swedish iron wire, one millimètre in diameter, and as its inherent polar force seemed great when held vertically in the earth's magnetic field, I measured in the induction balance this force compared with a similar column of the magnetic atmosphere which it displaced. The inherent polarity of this wire, simply rendered evident by the earth's magnetism, was 15,600 times greater than the column it displaced.

We cannot, either by induction, conduction, or concentration, produce a greater force in another body of similar displacement or size, otherwise we could easily create power from a feeble source. Thus the enormously greater magnetic power observed in iron than the same column of air which it displaces must be due to the *inherent* polarity of its molecules.

Amongst numerous bars of iron upon which I have experimented, one of ordinary hoop-iron, 2 centimètres wide, 40 centimètres long, and 1½ millimètre thick, not softened, possesses sufficient molecular rigidity to be apparently uninfluenced by earth's magnetism. When this rod is rendered neutral, we have but feeble polarity—mere traces when it is held vertically under the earth's magnetic influence; but if we apply a few successive torsions or vibrations to it when thus held, we have at once several thousand times greater polarity than before. Now, if iron had the power of deflecting or concentrating the earth's magnetism upon itself, it should not require the mechanical aid to molecular rotation given to it by these torsions or vibrations. Thus we are forced to conclude at least the existence of the inherent polarity of the molecules; and, if we admit this, we must also, as a necessary consequence, admit the rotation of these molecules, else we cannot explain why mechanical vibrations allowing freedom of motion should always produce the polarity in accordance with the directing cause. I have already shown that torsion and vibrations *per se* are apparently destructive of magnetism; consequently in this case Poisson's two fluids and Ampères parallel currents should, according to their theory, be mixed or heterogeneous, whilst according to the views I am sustaining the polarised molecules should obey, as compass needles, any magnetic directing cause whenever sufficient molecular freedom of motion allows free rotation.

The inherent polarity of iron may again be observed by drawing a flat rod of soft iron over one or both poles of a permanent magnet. This rod will then be powerfully magnetised, its remaining magnetism, when separated from the magnet, being sufficiently powerful to strongly deflect a suspended direction needle. A few slight torsions or vibrations will then completely discharge it. Now, suppose this operation repeated successively many thousand times, if there was no inherent polarity we should have gradually drawn all the polarity out of the magnet, and discharged it into the atmosphere. Nothing of the kind takes place. The molecules of the iron are simply rotated each time, and the only energy in work expended or lost comes from the arm of the experimenter, and the energy required would be strictly in accordance with the molecular freedom, or softness and hardness of the iron and steel: thus, whilst soft iron could be easily polarised and discharged by mechanical torsions, hard-tempered steel would require a far greater amount.

Dr. Warren De la Rue, F.R.S., kindly aided me in this part of the research by passing a current from his well-known chloride of silver battery through iron and steel wires. A condenser of 42·8 microfarads capacity, charged by 3,360 cells, was used. We passed this enormous electric charge longitudinally through the wires, and observations were made as to whether any change whatever was produced in their quality or inherent polarity, the result being that these wires gave exactly the same magnetic polarity from a given directing or inducing cause as before, being similar in nature and degree, consequently this enormous electric force had not changed or destroyed the original inherent polarity.

If the molecules possess inherent polarity and rotate upon their axes, similar to a series of compass needles having a slight degree of frictional rigidity, then, upon passing one pole of a magnet above them, they would turn symmetrically in one direction, and drawing the same pole of the magnet in the contrary direction would rotate them, and they would then remain symmetrically in the opposite direction.

A precisely similar effect takes place in a soft iron rod, placed east and west a few inches above a direction needle. Upon drawing the south pole of a powerfnl natural magnet at a few centimètres distance above the wire from east to west, the north polarities of the molecules successively turn in the direction of west, following the attraction of the south pole, as previously seen on the small compass needles. The rod is now magnetised with its north pole west, as indicated by the direction-needle below any portion of this rod. Upon passing the same south pole of the natural magnet in a contrary direction, the molecules all rotate, their north poles still turning successively to the south pole of the permanent magnet until its arrival at the end from which the first magnetisation commenced. The rod has now entirely changed its polarity, and its north pole is east.

This phenomenon is well known in the ordinary magnetisation of rods, where care is taken to draw the magnet always in a similar direction, or the poles would be reversed at each to and fro drawing. To account for this, on Coulomb-Poisson's theory, it would be requisite that, first, all the fluids be separated with their north fluids symmetrically in one direction, but on drawing back the magnet, these fluids would have to mix together, the north fluid passing through its south fluid to be finally opposite to its previous position, its coercive force doing the double work of allowing both fluids to mix and pass through each other, and finally keeping them entirely apart. Ampère's theory would require that from a haphazard arrangement the molecules should become symmetrically arranged upon the first passage of the magnet, then upon its reversed direction one half of the electric elementary currents should successively revolve in a contrary direction to arrive at neutrality before, finally, the other half followed the direction of the first half, and now all these currents would be revolving in the opposite direction to that upon the first magnetisation. We thus see that both these theories, whilst resting altogether upon assumption, are extremely complicated and improbable.

We might suppose from the theory which I am advocating, that upon the rotation of the molecules there would be some disturbance or mechanical trepidation; and such is found to be the case, as first observed by Page, and afterwards verified by Dr. Joule and De la Rive, in the molecular sounds produced in iron upon its magnetisation. Reis's first telephone was founded upon these sounds, and Du Moncel has made numerous researches upon this subject.

*"On the Molecular Rigidity of Tempered Steel," by Professor D. E. Hughes, F.R.S.—*Proceedings Institution of Mechanical Engineers*, pages 72-79, Jan., 1883.

In the last of my experiments cited, the sounds are too feeble to be heard, but by the application of the microphone these trepidations at once become audible.

That molecules of iron and other metals rotate with time, whose period becomes shortened by mechanical vibrations, is well known in metallurgy, the ultimate result being generally the passage from a fibrous condition, as in iron wires, to a high degree of crystallisation. For many years I employed a circular vibrating spring as the regulator of speed of my printing telegraph instrument, and although this spring was so regulated by means of a frictional break, or "Frein," as not to surpass its limits of elasticity, these springs were constantly breaking after a few days' use, and, as a matter of urgent necessity, I made special researches into the cause of this breaking after a few days' constant vibratory action. I found at the point of rupture a high state of crystallisation. Fibrous iron would thus become thoroughly crystallised and break in one day; the number of vibrations for an instrument in constant use during 24 hours being 1,209,600. Thus we could roughly estimate the life of iron in the form of one of these springs at one million vibrations. Copper crystallised in one hour, and all metals and alloys were inferior to steel, except aluminium bronze. The latter springs would stand six weeks' constant use, or some fifty millions of vibrations. I finally resolved this problem by spreading the amount of vibrating work over a spiral spring containing 3 mètres of steel rod wound into the same space as previously held by the straight rod of 30 centimètres; by this means the average life of these springs has become five years. Evidently the molecules of these fibrous springs must have rotated under the vibrations, in order to produce crystals. The same phenomenon is observed in axles of carriages receiving constant trepidations, large crystals being always found at the point of fracture. Again, if we rapidly magnetise and demagnetise an iron rod, we have the production of evident heat, due to the constant motion of its molecules.

(*To be continued.*)

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CORRESPONDENCE.

Secondary Generators.

Having carefully read the interesting articles that have lately appeared in your journal on the above subject, and having been for the last few months studying this branch of electricity, I have come to the same conclusion as yourselves as to the principle of Messrs. Gaulard & Gibbs' induction apparatus, viz., that it is an induction coil pure and simple. This, however, in no way lessens the credit due to those gentlemen for applying it in a practical form for lighting purposes; and to me it is surprising that the principle has not before been generally adopted for this purpose.

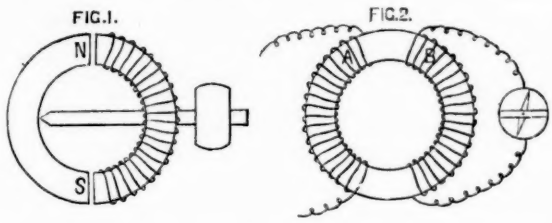
Faraday's original experiment consisted of an iron ring with a primary and secondary wire, the former connected with a battery, and the latter with a galvanometer. Of course, by breaking contact with the battery, an induced current was set up in the secondary conductor.

A modified experiment consisted of a number of superposed helices coiled on a bar of iron, the odd numbers forming the primary circuit, and the even numbers the secondary conductor; similar results to the above were obtained.

It is worthy of notice that Faraday's *next* experiment consisted of a bobbin with an iron core, whose coil in this case may be considered as the secondary conductor, and may be identified with the armature bobbins of the Siemens alternating dynamo. By moving this bobbin to or from the pole of a magnet an induced current was set up which was analogous to that produced in the first experiment by simply breaking contact with the battery.

In the first case, the only power necessary to produce this effect was to lift the primary conductor out of a cup of mercury; and in the latter case, physical force was expended in causing the bobbin to approach to and recede from the permanent magnet, and which is now accomplished by a steam-engine.

Let N S (fig. 1) represent a permanent magnet of a certain magnetic strength, having an armature, as shown, and let fig. 2 represent Faraday's original experiment above alluded to; A being the primary and B the secondary circuit. Suppose, moreover, that the



primary circuit is connected with a battery which is capable of rendering the half of the ring which A covers exactly equal in magnetic strength to the permanent magnet, fig. 1, plus the inverse current produced in itself on making contact.

Evidently if the armature (fig. 1) is rotated at 100 revolutions a minute it will develop an induced current of a certain strength, and at a 1,000 revolutions a greater strength of current will be produced. In like manner, if A, the primary circuit, fig. 2, is broken 100 times a minute a certain E. M. F. will be set up in B, the secondary circuit, and if A is broken 1,000 times an increased E. M. F. will result.

There can, I think, be no doubt that the cause and effect is the same in both cases, viz., the change of polarity of the soft iron core enveloped by the secondary conductor, this change being brought about in fig. 1 by mechanical means and in fig. 2 by electrical means. This leads one to think that the current produced in this manner does not depend on the conductor cutting lines of force, as in other modes of generating electricity; in fact the same effect may be obtained by approaching a bar permanent magnet to the end of a bobbin in a direction parallel to the length of the latter, and so simply shortening the lines of force. If it were possible to magnetise the bobbin, and to reverse its polarity by a thought, the same effect would doubtless be obtained. By having an automatic contact-breaker in fig. 2 this change can be produced quicker even than thought.

If the induced magnetism be supposed to bring into existence assemblages of closed currents in the magnet itself, according to Ampère's theory, or if, on the other hand, the currents cause the magnetism, it is easy to see that on setting up those currents inverse currents will be produced in an adjacent conductor, and that when the magnetic currents cease direct induced currents will be produced.

We will now suppose the above appliances at rest, ready for action. In fig. 1 we have a stored magnetic force in the permanent magnet, and in fig. 2 a stored electrical force capable of making half of the ring of equal magnetic intensity to the permanent magnet, fig. 1. Evidently, if the apparatus were very large a powerful steam-engine would be required in fig. 1, whilst a boy—in absence of more convenient means—could make and break contact with the battery. The question then resolves itself into this:—Would not the *difference* of power expended by the steam-engine and the boy *more* than provide the power necessary for keeping up a constant battery force?

It is an open question whether it would not be better, in the *present* state of electrical science, to supply an installation by means of an alternating dynamo of the Siemens type (those with comparatively long armature bobbins) *but let the armature remain at rest* and excite and periodically reverse the polarity of the field magnets by a small alternating-current machine.

The prospect for electricity for lighting and motive power purposes is infinitely better than ever it has been, and its success will be accomplished in more ways than one.

The object of this letter is to emphasise a striking analogy, and this will doubtless be a sufficient excuse for airing some known facts and occupying valuable space.

E. L. Voice.

1, Francis Street, W.C.
May 21, 1883.

Correction.

I wish to call your attention to an error in your issue of January 20th, page 53, in which you state that I am using the Brush light in my studio. I am using the Hochhausen, and cheerfully recommend it as the best I have ever seen.

W. Kurtz.

New York, *May 9th.*

Dynamo-Electric Machine Patents.

In reference to the queries by "Inquirer" in your valuable journal of May 5th, 1883, regarding dynamo-electric machine patents, I send you the following, relating more particularly to M. Pacinotti's machine. In 1860 M. Pacinotti had constructed a machine, which was described in detail in an Italian journal, *Il Nuovo Cimento*, in 1864, a copy of which publication is now to be seen in the British Museum. This machine contained in principle, and in fact in many of its details, the identical forms which are to be found to-day in the best dynamo-electric machines. I may add here that some eight or ten years previous to 1860 Page, an American electrician, constructed an electro-motor, which gave motion to a small, model locomotive, in Washington, D.C. (U.S.A.). *M. Pacinotti's machine, it must be admitted, was an electro-motor; but had his attention not been diverted to other channels of scientific research there is no doubt that he would have made a generator of it, as is indicated in his description of the motor, that it could be transformed into a generator of constant currents. It is unfortunate that M. Pacinotti was obliged to drop the subject of electricity, by reason of his employment as an assistant to Donati, the astronomer, at the observatory at Florence.

The jury of the "Exposition d'Electricité," 1881, recognised the merit of M. Pacinotti's invention, and awarded to him a diploma of honour.

I am indebted for my information to the pages of that excellent work, "La Lumière Électrique," par Em. Alglave et J. Boulard (Paris: 1882).

In Pacinotti's machine the conductor is an electro-magnet, the two poles of which are spread out in an arc of a circle, in which turns the induction ring, or, as Pacinotti calls it, "transverse electro-magnet" ("*electro-aimant transversal*"). This iron ring is furnished with projecting arms, between which are helices of copper wire. These helices are wound in the same direction, and the extremities of the wires are soldered to as many pieces of copper in a small wooden drum, which forms a commutator on which are fixed two metallic rubbers (brushes). The passage of the current in the helices magnetises the annular core of iron, which can be considered, says M. Pacinotti, as formed of two semi-circular magnets united by their poles of the same name. The magnetic poles of the ring being attracted and repelled by the poles of the fixed electro-magnet, the ring (armature) takes a rotatory movement. The same current circulates successively in the wire of the ring (armature) and in the magnetising helices of the inductor. In indicating how his motor can be transformed into a generator, M. Pacinotti explains the method of the production of currents of the same kind, and the rules to follow for the position of the rubbers (brushes).

So much for the Pacinotti motor. I would inform your correspondent that Pacinotti did not take out a patent for his motor, much less for a dynamo-electric machine.

As for the relation between the Gramme and Pacinotti bobbin or armature, there is but little difference. In a legal point of view there may be more difference than would at first seem apparent, and while I hesitate very much in expressing my humble views, I do so in hopes that it may be the means of bringing out the opinions of wiser heads than mine. There is no doubt that Pacinotti's invention was *published* in this country as early as 1864 (*vide Il Nuovo Cimento.*) It is claimed by the supporters of Gramme that to him is due the credit of improving the dynamo machine and making it of commercial value. This, of course, must be admitted; but as I only wish to deal with the armature, I will confine myself to that. Gramme *improved* also the armature; but if we look at the Gramme bobbin and compare it with the Pacinotti we find only a difference in mechanical detail and arrangement. Such difference is certainly an improvement; in other respects there is none. A core of iron, wound transversely in sections with copper wire, the terminals of each section connected to as many sections of the commutator. This description will do for all continuous current dynamos, with a few exceptions, chief among which is the Siemens armature, and this differs only in the relative position of and the winding of the wires. Pacinotti's armature core was an iron ring, Gramme's a ring formed by winding iron wire in a ring shape. I would here like to say, if this was allowed to be an *improvement* (patentable) on Pacinotti's core, why the Gramme owners can claim infringement by those inventors who also use the iron ring (improved in detail) of Pacinotti is difficult to see. If Gramme improved Pacinotti's core, certainly other inventors have an equal right to *start* where Gramme did, and improve each in a direction of his own choice, provided, of course, he does not tread on the Gramme specification (English), and what is that specification? †

From this extract it will be seen that Gramme's core must be an endless shape, of one piece of iron or a bundle of iron wires, no allusion being made to rings or insulating sections of cores from each other, nor of rings which are split, &c.

As "Inquirer" has evidently some interest, or at least leaning towards some particular form of dynamo, I would say simply this (but have him remember that I am "no authority")—that the opinion of nine of every ten persons who are authorities with whom he may speak will be that the Gramme patent has no real strength of claim, particularly as to the form and detail of construction of the bobbin; and if it is not exactly like the bobbin now used on the Gramme machine of to-day—which is a *core of iron wire*, wound transversely with copper wire, he need pay no more attention to the "notices" sent so frequently by a certain company to makers of dynamos than is paid by these same makers.

Some makers prefer to pay the royalty demanded, as a sure way of avoiding possible legal expenses for the short term previous to the expiration of the Gramme patents (June, 1884). These latter also recognise possibly the moral obligation due to an inventor for an improvement.

There are other points to which I may allude, which may be of some interest, and perhaps call out opinions. I refer to the specific differences in construction. Gramme's English specifications give no description from which a bobbin may be made, but if we take the Gramme bobbin as actually constructed, it will be seen that the insulated copper wire is wound in a certain manner, that one of the terminals is an outside wire, and leaves the outside of the bobbin and passes to the commutator connection, the other terminal is an inside wire and

passes from the inside across the other wires to the outside, thence to the commutator connection. In another, not the Gramme form of bobbin, it will be found that the wires are so laid as to make the terminals both outside wires. In Gramme's bobbin, iron wire is wound to form the core; in other bobbins the core is formed of iron rings, iron discs, iron bars, iron rings with projecting arms—arms like the spokes of a wheel—iron rings with depressions or notches, &c. *ad infinitum*, differences in form and arrangement, but all having one arrangement in common—an iron core; in fact, being in principle a Pacinotti (not Gramme) bobbin. Even if Gramme were entitled to the claim of being the first to devise the Pacinotti bobbin, the above-mentioned differences are worthy legal notice. Valuable claims have quite recently been decided invalid on far more minute differences than these (*vide* telephone litigations). But that which seems to me to have the greatest bearing on the subject is in the patent itself, its lack of specific claim. By referring to his patent (No. 1668, 1870) it will be noticed that Gramme makes *no* specific claim. "Now know ye that we . . . . . do declare the nature of said invention to be *particularly described* and ascertained in and by the foregoing statement thereof . . . . and having now described the nature of the said invention and in what manner the same is to be performed, I declare that I claim *the improvements in electro-magnetic machines, substantially as above described*. The italics are mine, and call attention to the only claim in the patent. Gramme must have been aware of what Pacinotti had done, for he makes no specific claim. Now, if in an English patent a single claim is illegal the whole is illegal. Hence we often see applications to "amend." Gramme could not claim the commutator, for Pacinotti had already invented the commutator. Gramme did not claim the bobbin or its peculiar or even general arrangement, for Pacinotti had already used this form of bobbin. Hence Gramme wisely (?) abstained from making any specific claim, knowing full well the strength of his patent, if strength it has, lay in dealing with generalities, and avoiding any specific claim to that which might conclusively be shown had been previously invented and a publication of the same previously introduced into this country, and thereby endangering the whole by the illegality of a part. As to the notice of the British Electric Light Company *v.* Anglo-American Brush Company, it does refer to the Gramme patents; but there seems to be little likelihood of the proceedings becoming very active until well into December next, much to the annoyance of many dynamo manufacturers and inventors, who are very anxious to have the matter settled one way or the other. The large interests affected, and the undoubted obstacle to the proper progress of dynamo machines, makes a speedy decision of this question of the greatest importance.

Chick.

London, *May 21st*, 1883.

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* By an examination of the orignal model of Pacinotti's machine, exhibited at the Exposition, 1881, the shaft will be found to have a pulley on its upper end, which was undoubtedly intended for transmitting the power when the machine was used as a *motor;* but we also find a pulley on the lower end of the shaft, from which a cord passes to a larger pulley or crank-wheel, by which, without doubt, the armature was put in motion when the machine was used as a *generator.* This would leave no room for doubt as to whether Pacinotti intended it as a motor only.

† "A.D. 1870. No. 1668. 9th June. Giving to the soft iron which is to become magnetised . . . the form of a solid or hollow ring, cylinder, or other suitable *endless* (italics are mine) shape, constructed either out of *one piece of iron* or a *bundle of iron wires*, and round the entire surface of which *endless* core is laid a series of coils of suitably isolated wire, of copper or other good conductor of electricity, in such a manner that the said coils . . . . may be considered as forming one continuous series of small bobbins, the wire of each two succeeding ones of which small bobbins being *soldered* or otherwise metallically connected together, end to end, so as to constitute one large endless bobbin. . . . ."

". . . . . The coils of wire of the large endless bobbin may, if wished, be replaced by coils made of strips or ribbon of brass, or other suitable good conductor of electricity suitably isolated from each other and from an endless core."

Long-Distance Telephoning.

I enclose the official report of the long-distance telephoning with the Lockwood-Bartlett instruments.

W. C. Barney.

Cleveland, Ohio, *March 21st*, 1883.

C. F. Livermore, Esq.,
President of the Molecular Telephone Company,
52, Broadway, New York.

DEAR SIR,—I beg to report a very successful test of the Molecular Telephone Company's instruments yesterday between this city and New York over the wires of the Postal Telegraph Company.

The result was perfect "commercial talk" between the two points, the distance being about 650 miles. Several transmitters of your company's construction were used; but the best results were obtained with one having sixteen points of contact "embedded in cork," as described in Lockwood and Bartlett's patent of 15th June, 1880. There was absolutely no induction and no singing, buzzing, or cracking sounds as in the Bell receiver. The receivers used were the goose-neck magnet, the end of which rests against a disc of wood, card-

board, or cork. Such words as "Mississippi," "Sybil," &c., were reproduced with accuracy and perfect articulation without confusion of sounds.

I submit the following data:—

1. Actual resistance of wires, 1,500 ohms.
2. Resistance of microphone, 6 ohms.
3. Resistance of secondary wire of induction coil, 175 ohms.
4. Cells of battery used, three Leclanché, medium size; but the best results were obtained with three Fuller cells.
5. Good results without induction coil with 40 cells gravity battery.
6. Weather fair and clear.
7. Transmitter having a microphone of carbon with 16 contacts embedded in cork.
8. Receiver goose-neck magnet; resistance of bobbin 50 ohms.
9. Induction none.
10. Conductor steel wire, $\frac{7}{16}$ inch diameter, 200 lbs. to the mile, electro-plated with 300 lbs. of copper to the mile.
11. Single wire on poles except through the cities, when the wire was in close proximity to numerous telegraph wires.
12. Articulation perfect.

Very respectfully yours,
HENRY E. WAITE.

Chicago, Illinois,
April 7th, 1883.

DEAR SIR,—I repeated the telephone experiments between New York and this point yesterday with success, the distance between the two offices being about 1,050 miles.

The weather here was very unfavourable, with a severe snow-storm raging, but we were able to transmit messages without difficulty, but not as well as at Cleveland. Here we had to repeat occasionally, but on the whole the result has been highly satisfactory. We used the same instruments as at Cleveland. Resistance of wire 1,800 ohms.

Very respectfully yours,
HENRY E. WAITE.

As you are pleased to say that "it appears useless to waste any further arguments with your correspondent, therefore we will only *assert* that the difference of potential between two ends of a conductor under the two conditions quoted is not the same." I hope you will permit me to follow your example, and to decline to waste any further arguments, but to *assert* my opinions. I am not so unsophisticated as to expect editors to stultify themselves in their own publications; at the same time I expect you will not condemn me to accept in silence your condemnatory *assertion*, and by my silence acknowledge my error.

I *assert* that "the difference of potential between the two ends of a conductor under the two conditions quoted *is the same*."

I *assert* that the difference of potential between the two ends of a conductor is produced by the combined effects of the resistance of the conductor and of the leakage.

I *assert* that the expression "resistance of a circuit," used by me and as used by telegraph engineers, does not mean the resistance of the metallic conductor *per se* only, but is used to express the result of the combined effects upon the current of that resistance and of the leakages, which result is the diminution of the potential at the receiving end of the conductor.

I *assert* that successful tests in a laboratory through a resistance coil of 25,000 ohms proves that equally successful results can be obtained over a CIRCUIT, the total resistance of which, inclusive of effect of leakages upon the current, does not exceed 25,000 ohms.

You are pleased to say "with reference to this last paragraph the statement amounts to this, that a circuit whose total conductor resistance is 50,000 ohms would, with a leakage in the *middle* amounting to 'dead earth,' still enable articulate speech to be transmitted to the further end, since the total resistance in this case would be 25,000 ohms."

In conclusion, permit me to make a few comments on your misinterpretation of what I wrote. In the first place, I used the expression "total resistances of the circuit, leakages included," but you here speak of the total resistances of the *conductor*, which is a very different thing from resistances of the *circuit*. I stated that articulate speech could be transmitted through* a *circuit* of 25,000 ohms resistance. You speak of a circuit whose total *conductor* resistance is 50,000 ohms, with a leakage in the middle amounting to "dead earth."

It seems to my feeble understanding that only the half of the conductor next to the battery is in the *circuit*, the other half being cut out of the circuit, and therefore the application of this curious statement cannot be applied to my assertion, because the instrument at the distant end of your conductor would not be in the *circuit*.

It appears to me that you have used the words "*conductor*" and "*circuit*" as synonymous. I hope you will find room for this letter in the next issue of your Review, in justice to a frequent (perhaps too frequent) contributor and correspondent.

May 28th, 1883. **W. C. Barney.**

*[Our correspondent said *over*, not *through*, a *circuit*, in the letter he refers to.—EDS. ELEC. REV.]

Incandescence Lamps.

With reference to Mr. Crompton's remarks on incandescent lamps, as given in your last week's issue, I must beg to take exception to his statement that the efficiency of the Swan lamp as compared with the Edison is as ten to seven, owing to the former being generally run at higher incandescence than the latter. I have had extensive opportunities of noting the comparative illuminating effects of 20 candle (nominal) Swan and 16 candle (actual) Edison lamps, and I certainly should hesitate to say that the former gives in practice a fraction of a candle more than its rival. As regards the higher incandescence of the Swan lamp, this is purely an optical illusion. Edison abandoned spiral carbons because he found that with this form the light was concentrated into a brilliant spot, dazzling to the eye, yet giving no more effective illumination than the form he ultimately fixed upon (the oblong horse-shoe), the light from which is equable from one end of the carbon to the other.

I have myself tested the truth of this by switching off and on a Swan and Edison lamp alternately, and noting that while the former appeared whiter than the latter it cast no more light on my writing paper.

I observe that Mr. Crompton speaks of so many candles per horse-power. To be explicit he should say per horse-power of current (746 volts).* In a practical system of electric lighting the generator plays quite as important a part as the lamp in the economy of production, and the effective horse-power given off by the engine sustains less or more lamps, accordingly as it actuates, say, a Bürgin dynamo converting 75 per cent. of the power into electrical energy or an Edison machine converting upwards of 90 per cent.

Continuous Current.

* [Our Correspondent evidently means "Watts." In regard to his remarks on the comparison of the Edison and Swan lamps he says exactly what Mr. Crompton pointed out. While the amount of light emitted by both lamps may be the same, yet the degree of incandescence is different, and the higher this degree, as exemplified in the case of the Swan lamp ("appeared whiter"), the greater efficiency per horse-power in the lamps.

The source from whence the electricity is supplied does not enter into the question at all when considering the efficiency of the *lamp only*, and not the *entire system*.

We quite believe that the Edison machine *per se* is more efficient than the Bürgin, but we have not had any opportunities of verifying that the actual difference in the machines is so great as to cover the superior efficiency of the Swan lamps.—EDS. ELEC. REV.]

Sounds Produced by a Plate Pressed against the Ear.

On page 329 I notice an experiment by Messrs. Probert and Soward of sounds produced by permitting a current to pass through the ear and tongue.

A similar experiment is recorded in an old work on ear diseases by Prof. von Tröltsch, "Würzburg," translated by John Rossa, New York. The following passage occurs on page 544:—

"In the faradisation of the ear in the manner above described most patients experience a painful contraction in the half of the tongue corresponding to the points of application, together with a peculiar sensation in the ear, like the sound from cooking, the rustling of a fly, as well as a darting pain in the ear."

I read this passage in May, 1877, and repeated the experiment with modifications, for the purpose if possible to use a plate on the ear as a speaking telephone receiver.

The best results with a rheotome are produced by placing this with one or two cells in the primary of an inductorium, grasp one secondary pole with the hand, and connect an insulator metal plate to the other secondary pole. Now press this plate against the ear, but interpose a sheet of paper, and a piercing tone is the result. By using an insulator plate on each ear a loud sound appears to be located in the top of the head where the auditory nerves centre. Unless large battery power is used no burning is perceptible where the paper touches the ear, nor are shocks necessarily produced.

E. Berliner.

Boston, *May 10th*, 1883.

Earth Currents.

In continuation of the paper which appeared in your issue of the 6th April, and with reference to the following passage by Mr. Preece (B. A. 28th August) that "there were certain natural currents flowing through the crust of the earth . . . . and at times acquire such considerable energy that with a telephone pressed to each ear, I have been told . . . . that the noise made is as though 'your brains were boiling.' This is due to intermittent currents produced by the polarisation of the earth plates." I should like to remark, after some experience of telephones on long lines in India, that one is forced to the conclusion that this "boiling" is due simply to atmospheric electricity; all lines are subject to it; those running close to the coast, where the evaporation under a hot sun is tremendous, are more disturbed by it than others, and it is greater on long lines than on short ones. It is greatest in the afternoon and evening of a hot day, and least in the early morning, when the aqueous vapour has settled down into an even and placid stratum. It is more violent before and after thunderstorms; can be heard better with the further end of the line insulated than when it is to earth, and is as strong on branch lines isolated from other wires as on multiple lines. The mere fact of its being so loud when earth is thrown off makes one certain that it is not caused by polarisation of earth plates. It would appear to be produced by minute electric storms.

It will probably be found an obstacle to long-distance telephony where a single wire is used.

E. O. Walker.

Belgaum, *1st May*, 1883.

The Efficiency of Electro-Motors.

Professors Ayrton and Perry have stated as reported in your No. of 19th inst., p. 414, that they have found the efficiency of the Griscom motor weighing 2·5 lbs. to be 17 per cent. Having reason to believe it much higher, I would be much obliged if these gentlemen would make public the experiments which led to the above conclusion.

C. R. Heap.

General Agent, the Electro-Dynamic Company of Philadelphia.
2, Scott's Yard, Bush Lane, Cannon Street.
London, *May*, 26, 1883.